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BY

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SURGEON AND LECTURER ON PHYSIOLOGY TO THE LONDON HOSPITAL
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PREFACE

MODERN SURGERY has advanced with such rapid strides, and in so many different directions, that it is almost impossible, within the space of a single volume, to give more than an epitome of its main principles. I have therefore touched but lightly upon controversial matters, and have endeavoured to make this book a practical one, in the hope that it may be of greater service to students and general practitioners. With this object, I have given special attention to the question of Treatment; and I have included under the heading of each organ a brief description of the malformations to which it is liable, and the various operations that may be performed upon it, instead of relegating them to chapters by themselves. The General Pathology of Surgical Diseases is dealt with in Part I.; that of Injuries in Part II. In Part III. the Diseases and Injuries of Special Structures and Organs are considered more fully. Throughout, I have endeavoured to enforce the idea that the chief aim and object of Surgery at the present day is, to assist the tissues in every possible way in their struggle against disease.

Through the kindness of the publishers, I have been enabled to make use of many illustrations from Bryant's 'Practice of Surgery,' Fergusson's 'Surgery,' and Astley Cooper's work on 'Fractures and Dislocations.' I am indebted to the CLINICAL SOCIETY and to MR. MORRANT BAKER for figs. 233 and 234, illustrating Charcot's disease; to Mr. Bowlby for figs. 40 and 44; to Mr. Greig Smith for several illustrations of the various methods of suturing the intestine; and to Mr. Nettleship for others in connection with ophthalmic surgery. Messrs. Krohne and Sesemann, Arnold, Weiss, Maw, and Schall, have also kindly allowed me to make use of various cuts from their catalogues. The rest of the illustrations, nearly two hundred in number, were (with four exceptions) drawn from original specimens by my brother Dr. J. A. Mansell Moullin (to whom I am indebted for the article on Diseases of the Female Generative Organs) or myself.

I have also to express my thanks to Mr. J. Hutchinson, junior, for his chapters on Diseases of the Skin and Eye; to Mr. T. Mark Hovell, for that on Diseases of the Ear and Larynx; and to Mr. F. S. Eve for that on Tumours.

C. W. MANSELL MOULLIN.

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CONTENTS

PART I

GENERAL PATHOLOGY OF SURGICAL DISEASES

CHAPTER I

PAGE

INJURY AND REPAIR . . 1

Inflammation 7
  Treatment of inflammation . 12
  Chronic inflammation . . 16

CHAPTER II

DISEASES DUE TO NON-INFECTIVE ORGANISMS

Septic fever 20
Sapræmia 21

CHAPTER III

DISEASES DUE TO INFECTIVE ORGANISMS

1. *Non-specific* Suppuration . 23
  Abscess 24
  Hectic 34
  Albuminoid degeneration . . 35
  Sinus and fistula . . . 36
  Ulceration 37
Gangrene 39
Phagedæna 50
Hospital gangrene 51
Phlegmonous inflammation . . . 51
Pyæmia 56

CHAPTER IV

DISEASES DUE TO INFECTIVE ORGANISMS

PAGE

2. *Specific* Erysipelas 62
  Septic infection or true septicæmia 66
  Anthrax 67
  Glanders 70
  Actinomycosis 72
  Tuberculosis 73
  Syphilis 78
  Leprosy 102
  Tetanus 105
  Rabies 109

CHAPTER V

TUMOURS

Cysts 113
Fibroma 119
Lipoma 121
Myxoma 122
Enchondroma 123
Osteoma 125
Myofibroma 126
Angeioma 126
Lymphangeioma 127
Neuroma 127
Sarcoma 128
Papilloma 133
Adenoma 134
Carcinoma 136

PART II

GENERAL PATHOLOGY OF INJURIES

CHAPTER I

THE GENERAL EFFECTS OF INJURY

PAGE
Shock 142
Delirium tremens 144
Traumatic delirium 146
Traumatic fever 146

CHAPTER II

THE LOCAL EFFECTS OF INJURY

PAGE
Subcutaneous injuries 148
Wounds 150
Repair of wounds 151
Skin-grafting 154
Treatment of wounds 159
Special kinds of wounds . . . 170
Cicatrices 171

CHAPTER III

BURNS AND SCALDS 176

PART III

DISEASES AND INJURIES OF SPECIAL STRUCTURES

CHAPTER I

DISEASES OF THE SKIN

PAGE
Eczema 184
Psoriasis 187
Lichen 188
Pemphigus 189
Lupus 190
Lupus erythematosus 193
Acne 194
Boils and carbuncles 195
Ulcers 196
Nævi 200
Warts 201
Molluscum contagiosum . . . 202
Scabies 202
Pediculosis 203
Favus 205
Ringworm 205
Tinea versicolor 207
Diseases of the Nails 207

CHAPTER II

INJURIES AND DISEASES OF BLOOD-VESSELS

1. *Injuries of vessels* 209
    Injuries of arteries . . . 214
    Injuries of veins . . . 229
PAGE
2. *Diseases of vessels* 231
    Angeioma 231
    Hæmophilia 233
    Diseases of arteries . . . 234
    ,, veins . . . 239
    Thrombosis 242
    Embolism 245
    Phlebitis 246
3. *Aneurysm* 249
    Traumatic aneurysm . . . 264
    Special aneurysms . . . 265
4. *Operations on arteries* . . . 280

CHAPTER III

INJURIES AND DISEASES OF LYMPHATICS

Injuries of lymphatics 302
Diseases of lymphatics 302
    Lymphangitis 302
    Lymphadenitis 304
    Lymphatic glandular tumours . 308
    Lymphangeiectasis . . . 311
    Lymphangeioma 311

CHAPTER IV

INJURIES AND DISEASES OF NERVES

PAGE
- *Injuries of nerves* 315
- *Diseases of nerves* 323
  - Neuritis 323
  - Neuralgia 326
  - Operations on nerves . . . 327
  - Neuroma 330

CHAPTER V

INJURIES AND DISEASES OF MUSCLES, TENDONS, &c.

- *Injuries of muscles, &c.* 331
  - Sprains and contusions . . 331
  - Rupture 332
  - Dislocation 334
- *Diseases of muscles, &c.* 335
  - Atrophy 335
  - Functional disorders . . . 335
  - Contracture 337
  - Myositis 337
  - Tenosynovitis 338
  - Ganglion 341
  - Dupuytren's contraction . . 341
  - Bursitis 346

CHAPTER VI

INJURIES AND DISEASES OF BONES AND JOINTS

SEC.
- 1. *Malformations and deformities* . 350
  - Congenital dislocations . . 350
  - Club-hand 352
  - Webbed fingers and toes . . 353
  - Talipes 353
  - Flat-foot 366
  - Deformities of the toes . . 368
  - Genu valgum 371
  - Rickety deformities . . . 372
- 2. *Injuries of bones* 375
  - Fractures 375
  - Repair of fractures . . . 380
  - Imperfect repair 386
  - Symptoms and diagnosis . . 392
  - Complications of fractures . . 396
  - Treatment of fractures . . 404
  - Fracture of the bones of the face 418
  - ,, clavicle . . 423
  - ,, scapula . . 429
  - ,, humerus . . 430
  - ,, radius . . 446
  - ,, ulna . . 449
  - ,, carpus and hand 451
  - Fracture of the pelvis . . 453
  - ,, femur . . 455
  - ,, patella . . 473
  - ,, tibia and fibula . 480
  - ,, bones of foot . 490
- 3. *Diseases of bone* 490
  - Atrophy 490
  - Hypertrophy 491
  - Inflammation 491
    - Phosphorus necrosis . . 500
    - Mercurial necrosis . . . 501
    - Acute suppurative ostitis . 501
      - Acute epiphysitis . . 511
      - Septic osteomyelitis . . 512
      - Exanthematous necrosis . 513
    - Syphilitic ostitis . . . 514
    - Rheumatic ostitis . . . 522
    - Tubercular ostitis . . . 523
    - Rickets 526
    - Ostitis deformans . . . 533
    - Osteomalacia 536
    - Tumours of bone . . . 537
      - Osteoma 537
      - Enchondroma 539
      - Fibroma 541
      - Sarcoma 541
      - Cysts 546
      - Carcinoma 546
- 4. *Injuries of joints* 546
  - Wounds of joints 546
  - Subcutaneous injuries . . . 550
  - Dislocations 552
  - Dislocation of the lower jaw . 561
  - ,, clavicle . . 563
  - ,, scapula . . 565
  - ,, humerus . . 567
  - ,, elbow-joint . 578
  - ,, wrist-joint . 581
  - ,, thumb . . 585
  - ,, hip-joint . 587
  - ,, patella . . 597
  - ,, knee . . . 598
  - ,, semilunar cartilages . 599
  - ,, ankle . . 602
  - ,, astragalus . 606
  - Subastragalar dislocation . . 607
- 5. *Diseases of joints* 609
  - Pathology 609
  - Mode of examination . . . 612
  - Synovitis 613
  - Arthritis 619
    - Suppurative arthritis . . 625
    - Pyæmic arthritis . . . 629
    - Puerperal arthritis . . . 630
    - Exanthematic arthritis . . 631

PAGE
Urethral arthritis 631
Gouty arthritis 634
Rheumatic arthritis . . . 636
Osteo-arthritis 637
Charcot's disease 646
Tubercular arthritis . . . 649
Senile tuberculosis 655
Diseases of special joints . . 659
Diseases of the hip-joint . 659
„ sacro - iliac joint . . 676
„ knee-joint . 678
„ ankle . . 685
„ shoulder . 686
„ elbow . . 687
„ wrist . . 688
Foreign bodies in joints . . 688
Anchylosis 691
6. *Excision of joints* 695
Excision of joints of the upper extremity 696
Excision of joints of the lower extremity 701

CHAPTER VII

INJURIES AND DISEASES OF THE HEAD

SEC.
Malformations 706
Injuries of the head 707
Injuries of the scalp . . . 708
Fracture of the skull . . . 710
Injuries of the brain . . . 718
Intracranial hæmorrhage . . 727
Injuries of nerves . . . 729
Traumatic epilepsy . . . 734
„ insanity . . . 735
Diseases of the head
Diseases of the scalp . . . 735
„ skull . . . 738
„ brain and meninges . . 741
Intracranial suppuration . . 746
„ tumours . . . 757
Trephining 761
Cerebral localisation . . . 762

CHAPTER VIII

INJURIES AND DISEASES OF THE BACK

1. *Malformations* 765
Spina bifida 765
Congenital sacral tumours . . 769
2. *Injuries of the back*
Sprains and wrenches . . . 771
Fractures and dislocations . . 773
Injuries of the spinal cord . . 785
PAGE
3. *Diseases of the back*
Disease of the spine . . . 789
Curvature of the spine . . 800
Inflammation of the spinal cord and meninges 809
Tumours of the cord . . . 812
Trephining 812

CHAPTER IX

INJURIES AND DISEASES OF THE EYE

Method of examination 814
Injuries of the eye 818
Diseases of the eye 821
Diseases of the conjunctiva . 821
„ cornea . . 825
„ iris . . . 829
„ lens . . . 831
Glaucoma 833
Diseases of the optic nerves and retina 835
Diseases of the choroid . . 839
Paralysis of ocular muscles . 840
Diseases of the eyelids, &c. . 841
Operations on the eye . . . 845

CHAPTER X

INJURIES AND DISEASES OF THE FACE AND NOSE

Malformations : Harelip, &c. . 850
Injuries of the face 853
Diseases of the face 854
Inflammatory affections . . 854
Tumours of the face . . . 858
Diseases of the nose 861
Epistaxis 862
Inflammatory affections . . 864
Tumours 867

CHAPTER XI

INJURIES AND DISEASES OF THE MOUTH AND JAWS

Malformations: Cleft palate, &c. . . 871
Injuries of the mouth and fauces . . 875
Diseases of the mouth and fauces . . 875
Inflammatory affections . . 875
Periostitis and ostitis . . . 879
Diseases of the antrum . . 880
Closure of the jaws . . . 882
Tumours of the mouth and jaws. 884
Operations upon the jaws . . 889

CHAPTER XII

INJURIES AND DISEASES OF THE TONGUE, SALIVARY GLANDS, AND TONSILS

PAGE

Malformations: Macroglossia, &c. . 892

Diseases of the tongue

- Glossitis 893
- Leucoplakia 895
- Tumours of the tongue . . 899
- Operations on the tongue . . 902
- ,, on the lingual nerve . 906

Diseases of the tonsils 907

Diseases of the salivary glands . . 911

CHAPTER XIII

DISEASES OF THE EAR AND LARYNX

Diseases of the ear

- Examination of the ear . . 914
- Diseases of the external ear . 917
- ,, middle ear . . 919
- ,, internal ear . 922

Diseases of the larynx

- Examination of the larynx . . 924
- Inflammation of the larynx . 925
- Tumours of the larynx . . 931
- Disorders of sensation . . 934
- Muscular paralysis and spasm . 935

CHAPTER XIV

INJURIES AND DISEASES OF THE NECK AND THROAT

Malformations: Branchial fistula, &c. . 937

Injuries of the neck

- Wounds 937
- Fracture of hyoid, &c. . . 941
- Foreign bodies in air-passages . 942
- Scald of he glottis . . . 946

Diseases of the neck

- Inflammatory affections . . 948
- Torticollis 949
- Tumours of the neck . . . 951
- Operations on the air-passages . 953

CHAPTER XV

DISEASES OF THE THYROID

Inflammation of the thyroid. . . 965

Simple enlargement, or goître . . 966

Malignant disease. 972

CHAPTER XVI

INJURIES AND DISEASES OF THE PHARYNX AND ŒSOPHAGUS

PAGE

Malformations 973

Injuries of the œsophagus . . . 973

Foreign bodies in the œsophagus . . 974

Diseases of the œsophagus . . . 976

Stricture 977

CHAPTER XVII

INJURIES AND DISEASES OF THE CHEST

Injuries of the chest-wall . . . 982

Injuries of the viscera 986

Diseases of the chest-wall . . . 995

Operations upon the thorax . . . 995

CHAPTER XVIII

INJURIES AND DISEASES OF THE ABDOMEN

SEC.

1. *Injuries of the abdomen* . . . 1002
2. *Surgical affections of the stomach*
   - Operations on the stomach . 1007
3. *Hernia* 1010
   - Irreducible hernia . . . 1016
   - Obstructed hernia . . . 1018
   - Inflamed hernia 1018
   - Strangulated hernia . . . 1019

Special herniæ

- Inguinal hernia 1038
- Femoral hernia 1043
- Umbilical hernia . . . 1046

4. *Intestinal obstruction*
   - Acute intestinal obstruction . 1049
   - Chronic intestinal obstruction . 1063
5. *Perityphlitis and peritonitis* . . 1075
6. *Operations on the intestines* . . 1079
7. *Surgical affections of the liver and pancreas* 1093

CHAPTER XIX

INJURIES AND DISEASES OF THE RECTUM

Malformations 1101

Examination of the rectum . . . 1102

Diseases of the rectum 1104

- Hæmorrhoids 1104
- Prolapse 1114
- Polypus 1117
- Pruritus 1118
- Proctitis 1119
- Periproctitis 1122
- Stricture 1130
- Malignant disease . . . 1134

CHAPTER XX

INJURIES AND DISEASES OF THE KIDNEY

PAGE
Malformations 1140
Injuries of the kidney 1142
Diseases of the kidney 1145
Suppression of urine . . . 1145
Hydronephrosis 1147
Tumours of the kidney . . 1150
Renal calculus 1152
Nephritis 1158
Pyelitis and pyelonephritis . 1161
Perinephritis 1166
Renal fistula 1167
Methods for differentiating the secretion of the kidneys . . 1168
Operations upon the kidneys . . 1169
Surgical aspect of the urine . . . 1172

CHAPTER XXI

INJURIES AND DISEASES OF THE BLADDER

Malformations 1183
Injuries of the bladder 1186
Diseases of the bladder 1189
Atony 1189
Irritability 1190
Incontinence 1192
Retention 1193
Cystitis 1198
Calculus 1203
Lithotrity 1210
Lithotomy 1216
Tumours 1230

CHAPTER XXII

DISEASES OF THE PROSTATE

Enlargement 1238
Malignant disease 1250
Inflammation 1251

CHAPTER XXIII

INJURIES AND DISEASES OF THE URETHRA

Injuries of the urethra:
Rupture 1256
Calculus 1258
The passage of catheters . . 1259
PAGE
Diseases of the urethra:
Inflammation 1264
Stricture 1272
Extravasation of urine . . 1291
Urinary abscess 1293
„ fistula 1295
The female urethra . . . 1296

CHAPTER XXIV

INJURIES AND DISEASES OF THE MALE ORGANS

Malformations of the penis . . . 1298
Diseases of the penis 1299
Diseases of the scrotum . . . 1300
Malformations of the testes . . . 1302
Diseases of the testes 1303
Neuralgia 1303
Inflammation 1304
Tumours 1311
Varicocele 1314
Hydrocele 1316
Hæmatocele 1320

CHAPTER XXV

DISEASES OF THE FEMALE GENERATIVE ORGANS

Inflammation of the ovaries and Fallopian tubes 1322
Ectopic gestation 1324
Tumours of the ovary and broad ligament 1326
Tumours of the uterus . . . 1338
Operations about the vulva and vagina 1348

CHAPTER XXVI

DISEASES OF THE BREAST

Malformations 1352
Diseases of the nipple 1352
Diseases of the gland 1354
Inflammation 1354
Tumours 1358
The male breast 1368
Excision of the breast . . 1369

CHAPTER XXVII

AMPUTATIONS . 1371

CHAPTER XXVIII

ANÆSTHETICS . . 1383

LIST OF ILLUSTRATIONS

FIG.			PAGE
1	A group of fibroblasts	*Bryant*	7
2	Hereditary syphilis, face in	,,	96
3	Lipoma of arm	,,	121
4	Diffused lipoma of neck	,,	122
5	Myxoma (microscopic appearance)	,,	123
6	Fibroma, osteoma, and enchondroma (microscopic appearance)	,,	124
7	Sarcoma (miscroscopic appearance)	,,	129
8	Adenoma ,, ,,	,,	134
9	Carcinoma ,, ,,	,,	135
10	Epithelioma of stump	,,	137
11, 12	Cicatrisation by skin-grafting	,,	155
13	Scissors for skin-grafting	,,	155
14	Irrigating-can	*Krohne and Sesemann*	160
15	Button suture	*Bryant*	164
16	Quilled ,,	,,	165
17	Twisted ,,	,,	165
18	Interrupted suture	,,	166
19	Glover's ,,	,,	166
20	Quilt ,,	*Greig Smith*	166
21	Cicatrix of burn on face	*Bryant*	172
22	,, ,, arm	*Fergusson*	172
23	The same after incision	,,	173
24	Lupus (microscopic section)	*Hutchinson*	191
25	Tinea and favus (microscopic)	,,	204
26	Chronic onychia	*Bryant*	207
27	Onychia maligna	*Fergusson*	208
28	Laceration of internal coats of artery	*Bryant*	214
29	Petit's tourniquet	*Fergusson*	217
30	,, ,, applied to the brachial artery	,,	218
31	,, ,, ,, ,, femoral ,,	,,	218
32	Signoroni's tourniquet	,,	218
33	Acupressure	*Bryant*	221
34	Effect of torsion on an artery	,,	222
35, 36	Aneurysmal varix	*Fergusson*	228
37	Arteriovenous aneurysm	*Bryant*	228
38	The same laid open	,,	228
39	Cirsoid aneurysm of scalp	*Fergusson*	232
40	Syphilitic arteritis	*Bowlby*	235
41	Varicose veins	*Bryant*	239
42	Section through popliteal aneurysm	,,	254
43	Diagrams of operations on aneurysms	,,	259
44	Femoral artery laid open after ligature	*Bowlby*	260

FIG			PAGE
45	Method of applying ligature to artery	*Bryant*	281
46	Aneurysm-needle	,,	281
47	Ligature of common carotid and facial arteries	*Adapted from Sédillot by Bryant*	283
48	,, subclavian and lingual arteries	,, ,,	287
49	,, axillary artery	,, ,,	290
50	,, brachial artery	,, ,,	291
51	,, ,, at bend of elbow	,, ,,	291
52	Lines of incision for brachial and radial arteries	*Fergusson*	292
53	Ligature of radial artery	*Adapted from Sédillot by Bryant*	292
54	,, radial and ulnar at the wrist	,, ,,	293
55	Incision for ligature of common iliac artery	,, ,,	294
56	Ligature of the external iliac and femoral arteries	,, ,,	296
57	Line of incision for ligature of the femoral artery	*Fergusson*	297
58	,, ,, posterior tibial artery	,,	299
59	Ligature of the posterior tibial artery	*Adapted from Sédillot by Bryant*	299
60	,, ,, ,, at ankle	*Original*	300
61	Line of incision for ligature of anterior tibial artery	*Fergusson*	300
62	Ligature of the anterior tibial artery	*Adapted from Sédillot by Bryant*	301
63	,, dorsalis pedis artery	,, ,,	301
64	Treves' cervical splint	*Krohne and Sesemann*	308
65	Lymphoma (microscopic)	*Bryant*	309
66	Serous cyst of neck	,,	312
67	Rider's bone	,,	331
68	Avulsed thumb	,,	332
69	Ruptured biceps	,,	332
70	Nussbaum's appliance for writers' cramp	*Krohne and Sesemann*	336
71, 72	Sternomastoid induration (microscopic)	*Bryant*	338
73	Compound palmar ganglion	,,	343
74	Dupuytren's contraction	*Fergusson*	344
75	Semi-solid bursa, laid open	*Bryant*	347
76	Supernumerary thumb	*Fergusson*	350
77, 78	Congenital displacement of hip	*Bryant*	351
79	Webbed fingers	*Fergusson*	353
80	Congenital talipes varus	*Bryant*	354
81	,, ,, valgus	,,	354
82	Tin splint for slight varus	*Arnold*	359
83	Little's shoe	,,	359
84	Little's modification of Scarpa's shoe	*Bryant*	360
85	Talipes equinus	*Fergusson*	362
86	,, calcaneus	,,	363
87	Barwell's shoe	,,	364
88	Walsham's shoe	*Arnold*	367
89	Lever for great toe	*Krohne and Sesemann*	370
90	Transverse fracture of femur	*Original*	375
91	Greenstick fracture of radius	,,	376
92	Comminuted fracture of clavicle	,,	376
93	T-shaped fracture of humerus	,,	376
94	Badly-united fracture laid open	,,	383
95	Ununited fracture of ulna	*Fergusson*	387
96	,, ,, tibia	,,	387
97	Pseudarthrosis of tibia	,,	388

FIG.			PAGE
98	The limb in the same case	*Fergusson*	388
99	Gutta-percha splint for lower jaw	*Original*	420
100	Wire ,, ,,	,,	421
101	Thomas' method of wiring jaw	,,	422
102	Displacement of broken clavicle	*Fergusson*	424
103	Triangular bandage applied	*Original*	425
104	Bandage for fracture of clavicle	,,	426
105, 106, 107	Sayre's bandage for fracture of clavicle	—	428
108	Pick's bandage	*Original*	428
109	Fracture of neck of scapula	*Fergusson*	429
110	,, surgical neck of humerus	,,	431
111	Bandage for fractured neck of humerus	*Original*	432
112	Line of upper epiphysis of humerus	,,	433
113	Splint for fracture of shaft of humerus	,,	437
114	Fracture of lower end of humerus	*Fergusson*	439
115	Badly-united fracture of humerus	,,	440
116	Fracture of inner condyle of humerus	,,	442
117	Epiphysis (lower) of humerus	*Original*	443
118	Separation of upper epiphysis of radius	,,	444
119	Diagram of Colles' fracture	,,	446
120	Section through Colles' fracture	*Bryant*	446
121	Arm in Colles' fracture	*Fergusson*	447
122	Gordon's splint	*Original*	449
123	Carr's splint	*Bryant*	449
124	Fibrous union of olecranon	*Fergusson*	450
125	Fracture of Pelvis	,,	455
126	Bryant's triangle	*Bryant*	457
127	Intra-articular fracture of neck of femur	*Original*	458
128	Section through neck of femur	,,	458
129	,, ,, (horizontal)	,,	460
130	Impacted fracture through base of neck	,,	461
131	,, ,, intra-articular	,,	462
132	Separation of great trochanter	*Bryant*	463
133	Liston's splint	*Maw and Thompson*	466
134	Desault's splint	*Krohne and Sesemann*	466
135	Mode of applying stirrup	*Original*	467
136	Liston's splint applied	,,	467
137	Thomas' knee-splint	,,	468
138	Badly-united fracture of femur	*Fergusson*	468
139	McIntyre splint applied	*Original*	469
140	Hodgen's splint applied	*Bryant*	469
141	Fracture of femur in infancy	*Original*	470
142	Vertical separation of lower epiphysis of femur with bony union	,,	470
143	Fracture of lower end of femur	,,	471
144, 145	Fractured patella	*Fergusson*	473
146	Section through knee after fracture of patella	*Original*	474
147	Outline of knee in fracture of patella	*Fergusson*	474
148	Bony union of fractured patella	*Original*	475
149	Fibrous union of fractured patella	,,	475
150	Splint for fracture of patella	,,	476
151	Malgaigne's hooks	*Weiss*	477
152	Leather splint for knee	*Maw and Thompson*	478
153	Back and side splints for fracture of leg	*Original*	481
154	Stocking splint for leg	,,	483
155	Bavarian splint	,,	484

FIG.			PAGE
156	Section through foot showing effect of eversion	*Original*	486
157	,, ,, ,, inversion	,,	486
158	Vertical splitting of tibia	,,	487
159	Dupuytren's splint	*Fergusson*	487
160	Atrophy of bone	*Original*	490
161	Chronic traumatic ostitis	,,	493
162	Inequality of growth consecutive to inflammation and necrosis	,,	494
163	Chronic abscess of bone	,,	496
164	Chronic osteomyelitis	,,	500
165	Phosphorus necrosis of jaw	,,	501
166	Acute suppurative osteomyelitis of tibia	,,	504
167	Chronic osteomyelitis of lower end of femur	,,	505
168	Section through bone after amputation and osteomyelitis	,,	513
169	Tubular sequestrum	,,	513
170	Syphilitic caries of skull	,,	516
171	,, osteosclerosis of skull	,,	517
172	Parrot's nodes	,,	518
173	Tubercular caries of radius	,,	524
174	Section through an epiphysis in a case of rickets	,,	526
175, 176	Rickety femur and tibia	,,	528
177	Skull from a case of ostitis deformans	,,	533
178	Femur from a case of ostitis deformans	,,	533
179	Attitude in ostitis deformans	*Bryant*	534
180	Exostosis of frontal sinus	,,	537
181	Exostosis from frontal sinus	,,	537
182	Subungual exostosis	,,	538
183	Enchondroma of finger	*Original*	539
184	,, hand	*Bryant*	540
185	Central sarcoma of tibia	*Original*	542
186	,, fibula	,,	542
187	Periosteal sarcoma of femur	,,	543
188	Old subcoracoid dislocation—glenoid fossa	,,	554
189, 190	New sockets in old dislocations of hip	*Astley Cooper*	555
191	Dislocation of lower jaw	*Fergusson*	561
192	Old dislocation of humerus	*Original*	568
193	Subcoracoid dislocation	,,	569
194	,, ,, capsule laid open	,,	571
195	,, ,, showing effect of rotation outwards and abduction	,,	571
196	Rotation outwards of arm in reduction of dislocation	,,	572
197	Circumduction of arm	,,	572
198	Forced rotation inwards of humerus	,,	573
199	Reduction of dislocation by heel in axilla	*Fergusson*	574
200	Clove-hitch	,,	574
201	Reduction of dislocation by upward traction	,,	575
202	Dislocation of bones of arm backwards	*Modified from Astley Cooper*	578
203	Unreduced dislocation of elbow	*Fergusson*	581
204	Subluxation of radius in an infant	*Original*	584
205	Thumb-forceps	*Fergusson*	585
206	Dislocation of proximal phalanx of thumb	*Original*	586
207	Complete dislocation of proximal phalanx of thumb	,,	586

FIG.			PAGE
208	Complex dislocation of proximal phalanx of thumb	*Original*	586
209	Dislocation of finger	*Fergusson*	587
210	Dorsa dislocation of hip	*Astley Cooper*	589
211	Sciatic dislocation of hip	,,	589
212	Thyroid dislocation of hip	,,	589
213	Pubic dislocation of hip	,,	589
214	Dislocation on the dorsum above the tendon	*Original*	590
215	,, ,, below the tendon	,,	590
216	View of pelvis from below in sciatic dislocation	,,	592
217	Method of applying pulleys in reduction of dislocations	*Fergusson*	596
218	Pott's fracture	,,	602
219	Dislocation of foot backwards	,,	603
220	Subastragalar dislocation	*Original*	606
221	Absorption of articular cartilage by granulations	,,	610
222	Abscess in upper epiphysis of tibia	,,	624
223	Necrosis of articular cartilage	,,	626
224	Fibrillation of cartilage	,,	637
225	Absorption of cartilage in osteoarthritis	,,	637
226	Elbow-joint in advanced osteoarthritis	,,	638
227	Absorption of neck of femur in osteoarthritis	,,	639
228	Papillary synovitis	,,	639
229	Rheumatoid arthritis of shoulder with absorption of biceps tendon	,,	641
230	Shoulder in Charcot's disease	,,	646
231	Hand in Charcot's disease	,,	647
232	Elbow in Charcot's disease	,,	648
233, 234	Knee-joint in Charcot's disease	*Clinical Society*	648
235	Incipient tubercular infiltration of upper end of femur	*Original*	651
236	Incipient tubercular infiltration of upper end of tibia	,,	651
237	Sequestrum in neck of femur	*Bryant*	659
238	Separation of head of femur	,,	660
239	Destruction of head of femur	*Original*	660
240	Diagnosis of hip-disease	*Krohne and Sesemann*	662
241, 242	Attitude in early hip-disease	*Modified from Wright*	663
243, 244	Tilting of pelvis and abduction	*Original*	664
245	Attitude in advanced hip-disease	*Bryant*	668
246	Bryant's splint	*Maw and Thompson*	669
247	Abduction and extension in hip-disease	*Original*	670
248	Adduction and extension in hip-disease	,,	670
249	Section through trunk and limb to show position of Thomas' splint		671
250	Measuring for Thomas' splint	*Krohne and Sesemann*	672
251	Thomas' wrenches	,,	673
252	Method of lifting patient with Thomas' splint applied	,,	673
253	Thomas' hip splint applied	,,	674
254	Double Thomas' splint	,,	674
255	Chronic disease of knee-joint, secondary to ostitis	*Original*	679
256	Primary tubercular synovitis of knee	,,	680
257	Section through knee-joint in a state of advanced arthritis	,,	681
258	Thomas' knee-splint with patten	*Krohne and Sesemann*	683

FIG.			PAGE
259	Thomas' knee-splint applied	*Krohne and Sesemann*	683
260	Abscess in head of humerus	—	686
261	Disease of elbow-joint	*Fergusson*	687
262	Section through anchylosed elbow-joint	*Original*	693
263	Excision of elbow-joint	—	698
264	Incisions for excision of wrist-joint	—	700
265	Lister's splint for excision of wrist	—	701
266	Meningocele	*Bryant*	706
267	Encephalocele	,,	707
268	Exfoliation of skull after injury	*Original*	710
269, 270	Fracture of vault of skull, inside and outside	,,	711
271	Punctured fracture of skull	,,	713
272	Fracture of base of skull	,,	715
273	Hæmorrhage from middle meningeal artery	,,	728
274	Horn and sebaceous cysts of scalp	*Bryant*	738
275	Necrosis of frontal bone (syphilitic)	,,	740
276	Section through mastoid process and lateral sinus	*Original*	749
277	Hernia cerebri	*Bryant*	756
278	Trephining	*Fergusson*	762
279	Localisation of the cerebral convolutions	—	763
280	Meningomyelocele laid open	*Original*	767
281	Spina bifida (diagrammatic)	,,	768
282	Cicatrix from a case of spina bifida	*Bryant*	768
283, 284	Congenital coccygeal tumours	,,	770
285	Fracture of spine	*Original*	774
286	Dislocation ,,	*Bryant*	774
287	Anchylosis of dorsal vertebræ after caries	*Original*	790
288	Tubercular ostitis of spine	,,	791
289	Atlo-axoid disease	,,	795
290	Sayre's tripod	*Arnold*	796
291	Double Thomas' splint for caries of spine	*Krohne and Sesemann*	798
292	Sayre's jury-mast	*Bryant*	798
293	Lateral curvature of spine	*Original*	804
294	Spine from a case of lateral curvature	,,	805
295	Transverse section through thorax from a similar case (advanced)	,,	805
296	Extreme scoliosis	*Bryant*	806
297	Barwell's sling	*Original*	809
298	Prolapse of iris	,,	820
299	Granular eyelid	*Nettleship*	824
300	Pannus	,,	824
301	Teeth, syphilitic and mercurial	*Original*	829
302	Ophthalmoscopic appearance in papillitis	*Nettleship*	836
303	Field of vision in tobacco-amaurosis	*Original*	837
304	Atrophy of choroid from inflammation	*Nettleship*	839
305	Beer's cataract-knife	,,	843
306	Melanotic growth on edge of eyelid	*Original*	844
307, 308	Iridectomy	*Nettleship*	847
309	Double harelip	—	850
310	Operation for single harelip	—	851
311	,, ,, harelip with unequal sides	—	851
312	,, ,, double harelip	—	852
313	Lipoma nasi	*Fergusson*	859
314	Bellocq's sound	,,	863
315	Nasal speculum	*Arnold*	866
316	Method of grasping nasal polypi	*Fergusson*	868

FIG.			PAGE
317	Smith's gag	*Maw and Thompson*	872
318	Coleman's gag	,, ,,	872
319	Cleft of soft palate with lines of incision	*Fergusson*	872
320	Smith's tubular needles	—	873
321	Cleft of palate with lateral incisions	*Original*	873
322	Ranula	*Bryant*	885
323	Macroglossia	*Fergusson*	893
324	Chronic superficial glossitis	*Original*	896
325	Epithelioma of the tongue	,,	900
326	Tonsillotome	—	910
327	Salivary calculus	*Bryant*	912
328	Submaxillary tumour	,,	913
329	Allen's air-pad	*Krohne and Sesemann*	915
330	Air-bag for Politzer's inflation	,,	915
331	Brunton's auriscope	*Arnold*	916
332	Ear-forceps	,,	919
333	Golding Bird's dilator	—	945
334	Œdematous laryngitis	*Original*	946
335	Trachea-dilator	—	955
336	Parker's suction-tube	*Maw and Thompson*	955
337	Durham's cannula	*Weiss*	956
338	Parker's cannula	*Arnold*	956
339	Hahn's tampon	*Weiss*	957
340	O'Dwyer's intubation tubes	,,	961
341	Parenchymatous goître	*Original*	967
342	Cystic bronchocele	,,	968
343	Colloid degeneration of thyroid	,,	970
344	Cystic ,, ,,	,,	971
345	Horsehair probang	*Bryant*	975
346	Coin-catcher	—	975
347	Malignant stricture of œsophagus	*Original*	978
348	Ribs united by callus	,,	984
349	Strapping for chest	*Bryant*	984
350	Diagram showing position of viscera	,,	1003
351	Oblique inguinal hernia	,,	1012
352	Direct ,, ,,	,,	1012
353	Femoral hernia	,,	1013
354	Coles' truss	*Maw Thompson*	1014
355	Single circular truss	—	1014
356	Double femoral truss	*Maw Thompson*	1015
357	Pad for irreducible hernia	*Bry*	1017
358	Unstrangulated hernia		1019
359	Strangulated intestine	,,	1019
360	Congestion and hæmorrhage into intestine from strangulation	,,	1020
361	Reduction *en masse*	*Original*	1026
362, 363, 364	Varieties of incomplete reduction	,,	1026
365	Method of dividing stricture in hernia	*Fergusson*	1029
366	Stricture of intestine after strangulation	*Bryant*	1033
367	Congenital hernia complete	*Original*	1034
368	,, ,, incomplete	,,	1034
369	Infantile hernia	,,	1035
370	Incision for inguinal hernia	*Fergusson*	1038
371	Pad formed in MacEwen's operation	*Original*	1040
372	Valvular shape of inguinal canal	*After Astley Cooper*	1041
373	MacEwen's operation for radical cure	—	1042

FIG.			PAGE
374	Femoral hernia	*Original*	1043
375	Strangulation of intestine by band	,,	1050
376	Prolapse through Meckel's diverticulum	,,	1051
377	Intussusception	,,	1053
378	Malignant disease of intestine	,,	1065
379	Malignant stricture (annular)	,,	1065
380	Nélaton's operation	*Bryant*	1082
381	Method of securing intestine in lumbar wound	*Original*	1082
382	Artificial anus after lumbar colotomy	*Bryant*	1083
383	Method of securing intestine in inguinal colotomy	*Original*	1084
384	Lembert's suture	*Greig Smith*	1086
385	,, ,, tied	,,	1087
386	Greig Smith's method of intestinal suture	,,	1087
387	Allingham's speculum	*Maw and Thompson*	1103
388	Internal hæmorrhoids	*Bryant*	1109
389	Clamp for cauterising hæmorrhoids	*Arnold*	1111
390	,, crushing hæmorrhoids	,,	1111
391	Prolapse of rectum	*Bryant*	1115
392	Probe passed through anal fistula	,,	1129
393	Method of dividing fistula	*Fergusson*	1129
394	Single median kidney	*Original*	1140
395	Hydronephrosis	,,	1148
396	Calculus encysted in kidney	,,	1155
397	Calculous and suppurative pyelitis	,,	1156
398	Tubercular pyelitis	*Original*	1162
399	Urinary deposits—urates	*Bryant*	1180
400	,, ,, uric acid	,,	1180
401	,, ,, oxalate of lime	,,	1180
402, 403	,, ,, phosphates	,,	1180
404	,, ,, epithelium	,,	1181
405	,, ,, spermatozoa and epithelium	,,	1181
406	Urinary deposits—casts	,,	1181
407	Ectopia vesicæ in the male	,,	1183
408	,, female	,,	1183
409	Methods of tapping bladder	*Fergusson*	1196
410	Tapping the bladder through the rectum	*Bryant*	1198
411	Hypertrophied and sacculated bladder	*Original*	1199
412	Uric acid calculus with oxalate of lime	*Bryant*	1205
413	Oxalate of lime calculus	,,	1205
414	Cystin calculus	,,	1205
415	Enlarged prostate, with sacculated bladder	*Original*	1208
416	Sound with bulbous end	*Arnold*	1208
417	Bigelow's lithotrite	*Weiss*	1211
418	Thomson's lithotrite	,,	1211
419	Lithotrity, method of seizing calculus	—	1212
420	,, ,,	—	1212
421	Thompson's bladder-aspirator	*Arnold*	1213
422	Evacuating tubes	,,	1214
423	Lithotomy knives	*Bryant*	1217
424	Clover's crutch	*Weiss*	1217
425	Lithotomy-staff	—	1218
426	Incision for lateral lithotomy	*Fergusson*	1218
427	Lithotomy with curved staff	*Bryant*	1219
428	,, straight staff	*Key*	1219
429	Blunt gorget	—	1220
430	Lithotomy-forceps	—	1220

FIG.			PAGE
431	Lithotomy scoop	*Maw and Thompson*	1220
432	Buckston Browne's tampon	*Arnold*	1222
433	Angular staff	—	1224
434	Fibropapilloma of bladder	*Original*	1231
435	Epithelioma of bladder	,,	1232
436	Leiter's cystoscope	*Schall*	1234
437	Thompson's bladder-forceps	*Weiss*	1235
438	Dilator for female urethra	*Krohne*	1237
439, 440	Enlargement of the prostate	*Original*	1239
441	Neck of bladder seen from within in a case of enlarged prostate	,,	1249
442	Prostatovesical calculus	*Bryant*	1254
443	Prostatic calculi with prolapse of ureter	*Original*	1254
444	Various forms of catheters	—	1260
445	Method of tying in catheter	*Bryant*	1263
446	Instrument for tying catheter in	*Arnold*	1264
447	Leiter's panelectroscope	*Schall*	1271
448	Stricture of urethra with diseased bladder	*Original*	1275
449	Otis's urethrameter	*Maw and Thompson*	1277
450	Bulbous sound	*Arnold*	1279
451	Holt's dilator	—	1285
452	Civiale's urethrotome	*Maw and Thompson*	1286
453	Otis's urethrotome	*Weiss*	1286
454	Teevan's urethrotome	*Arnold*	1287
455	Syme's staff	—	1288
456	Wheelhouse's operation	*Original*	1289
457	Grooved staff	*Bryant*	1289
458	Teale's gorget	,,	1290
459	Cock's operation	,,	1290
460	Division of stricture in paraphimosis	,,	1299
461	Strapping testicle	,,	1306
462	Gummatous disease of testis	*Original*	1307
463	Tubercular epididymitis	,,	1309
464	Hernia testis	*Bryant*	1310
465	Cystic disease of testis	,,	1311
466	Varicocele	*Original*	1315
467	Encysted hydrocele of cord	,,	1318
468	Spermatocele	,,	1318
469	Tapping a hydrocele	*Bryant*	1319
470	Obliteration of tunica vaginalis	*Original*	1320
471	Inflammation and distension of Fallopian tubes	,,	1322
472	Multilocular ovarian cyst	,,	1327
473	Dermoid cyst of ovary	,,	1327
474	Papillary cyst of ovary	,,	1328
475	Uterine fibroids	,,	1340
476, 477, 478	Ruptured perineum, operation for	,,	1350
479	Cystic tumour of breast	*Bryant*	1361
480	Colloid scirrhus of breast	*Original*	1363
481	Teale's amputation	*Bryant*	1372
482	Carden's amputation	,,	1372
483	Amputation of forearm	,,	1374
484	Outline diagram for amputations of thumb and fingers	,,	1375
485	Furneaux Jordan's amputation at the hip	,,	1376
486	Stephen Smith's method of amputating	,,	1377
487	Stump after Stephen Smith's amputation	,,	1377

FIG.			PAGE
488	Amputation of leg by mixed method	*Bryant*	1378
489	Stump left after amputation by mixed method	,,	1378
490	Pirogoff's amputation	,,	1379
491	Stump after Pirogoff's amputation	—	1379
492	Stump after Chopart's amputation	*Fergusson*	1380
493	Lines for Tripier's amputation	*Bryant*	1380
494	Stump after Hey's amputation	*Fergusson*	1381
495	Amputation of great toe	,,	1381
496	Removal of metatarsal bone of great toe	,,	1381
497	Stump left after excision of metatarsal bone of great toe	,,	1381

PART I

GENERAL PATHOLOGY OF SURGICAL DISEASES

CHAPTER I

INJURY AND REPAIR. INFLAMMATION

INJURY AND REPAIR

THE immediate effect of an injury is to kill some of the structures upon which the brunt of the violence falls and impair the vitality of others, the extent and severity of the damage sustained depending partly upon the intensity of the agent, partly upon the condition of the tissues. As soon as the irritant ceases to act, repair begins, provided the violence has not been so great as to destroy life altogether: if it continues, or if, before its effects have died away, a second is inflicted, impairing vitality further still, what is known as inflammation follows. Two things, therefore, have to be considered in estimating the effect produced—the severity and persistence of the irritant, and the condition of nutrition of the tissues.

OF THE VARIOUS CAUSES OF INJURY

Irritants are divided into two classes, the organised or living, and the unorganised, which may be mechanical, physical, or chemical. The distinction is not a logical one, as the former act either mechanically, by blocking the blood-vessels, or chemically, by means of certain poisons they produce; but it is convenient for this reason, that the one is endowed with an independent existence, and the other is not.

1. *Organised Irritants*

Certain animal parasites (such as the chigoë) are occasionally met with living in the tissues, but they are so rare as to be of comparatively little consequence; the more important ones are microscopic, unicellular organisms belonging to the class Schizomycetes, multiplying by transverse division, and, in the case of the rod-like forms, by spores as well.

a. Of these some can only live in dead material. They are constantly present in the bronchi and the alimentary canal, they enter freely with the food and the air; but even if they are injected into the blood they are either killed or eliminated with the urine; they are non-pathogenic, they do not of themselves give rise to any disease. Such, for example, is the bacillus of putrefaction. This cannot exist in the tissues so long as they are alive; but where it can gain entrance to a collection of pus or of wound-discharges exposed to the air it thrives most vigorously and forms a chemical poison which is the cause of some of the varieties of wound fever.

b. Others can exist in the tissues or in the blood, but are unable to affect them injuriously unless their power of resistance has been lowered by other local or constitutional causes. Such are the organisms which give rise to the formation of pus (staphylococcus pyogenes aureus, albus, or citreus, streptococcus pyogenes, and several more); they do not cause specific diseases, but according to the circumstances under which they enter, and their surroundings, they are followed by suppuration, gangrene, pyæmia, noma, phagedæna, and other acute inflammatory disorders. Erysipelas is still open to doubt; there may be a definite specific coccus, or it may be caused by the streptococcus pyogenes acting under peculiar conditions.

c. A third class again is specific, being followed invariably by the same definite disorder. Some of these are attended by local inflammation (tubercle, syphilis, glanders, anthrax, &c.); others, such as tetanus and hydrophobia, give rise to constitutional symptoms only.

2. *Unorganised Irritants*

Mechanical, such as cuts, bruises, friction, or tension. A simple incised wound heals at once, without inflammation. Certain tissue-elements are killed; a very slight amount of blood is extravasated between the cut edges, but if there is no further hurt or injury the natural process of repair begins at once. If the blood decomposes, if the wound is repeatedly rubbed, or if a suture is put in so tightly as to cause tension, a fresh injury is inflicted, the vitality of the surrounding tissues is lowered, and inflammation sets in and continues until the irritant is removed.

Physical.—Heat acts in the same way. A cautery plunged into a nævus leaves a hole with blackened, charred edges; but if no fresh irritant is allowed to appear, the wound is repaired without inflammation. A burn covered up thoroughly from the air and protected from decomposition, heals without further trouble, unless pyogenic or other organisms gain access to it in some way. Intense local cold produces the same effect. How a general chill acts when it causes internal inflammation (pneumonia, for example) is not certain.

Chemical.—The same may be said of these. Nitric acid applied to the skin forms a scab under which repair is completed without further destruction or loss of tissue. If, however, a continuous stream of poisonous compounds is poured into the blood, or allowed to act upon the tissues, the most intense fever and the most widespread destruction may follow.

It is still open to question whether the nervous system can of itself excite inflammation. There is no doubt that a part of the body separated from the central organs is especially liable to become inflamed if it is injured in any way; but this is not the point. It seems probable that certain disorders—herpes zoster, acute bedsores, and some forms of arthritis—are the direct result of affections of distant portions of the nervous system, and that, therefore, nerve-irritation must be regarded as a direct exciting cause; but in what way it can act must remain undefined until more is known of the influence of the nerves upon the nutrition of the tissues during health.

OF THE INFLUENCE OF THE CONDITION OF THE TISSUES

The effect produced by an irritant depends not only upon the irritant itself, but upon the condition of the tissues. In old age, where the arteries are atheromatous and the circulation feeble, or after prolonged exposure to cold, a scratch or bruise so trivial that under other circumstances it would scarcely have attracted attention, may lead to the death of the part it affects, and, by the changes that follow, prove the cause of extensive gangrene.

I. The circulation may be defective. There may be a deficient supply of blood, or the part may be engorged and congested. Everything that tends to prevent a fair amount of blood flowing to a part—arterial atheroma, cold, strangulation, as in the case of a hernia or Esmarch's bandage if too long applied—lowers its vitality and renders it less able to resist injury. In the same way, if there is any difficulty to the return of blood—if, for example, the veins are varicose and the tissues congested and œdematous—the most feeble irritant may cause a very extensive degree of inflammation.

II. The quality of the blood may be defective: Bright's disease, scurvy, or diabetes may be present. It is probable that gout, intemperance, starvation, and possibly rheumatism act in this way too.

III. Interference with the nerves going to a part undoubtedly predisposes to inflammation, but whether this is a direct result, or indirect, due to the fact that no work is done and that consequently the nutrition of the part is carried on without energy, is uncertain.

Besides these causes there are others, many of them hereditary, concerning which it is impossible to say more than that the tissues themselves are peculiarly susceptible, sometimes to every kind of irritant, sometimes only to certain special forms, such, for example, as tubercle.

THE EFFECT OF A SINGLE INJURY

The immediate effect of an irritant of more than the slightest degree of intensity is to kill some of the tissue-elements and lower the vitality of the others. Unless the blood-vessels are ruptured, so that there is some extravasation, the change that actually takes place is, for the most part, beyond our power of observation; it is known that after powerful electric shocks the corneal corpuscles and wandering leucocytes cease their movements and become fixed in shape, and probably the same result is produced by other irritants of equal degrees of intensity; but even of this it is impossible to say more than that the living protoplasm has undergone a process of coagulation. The interchange of oxygen and carbonic acid comes to an end; the plasma ceases to circulate in the interstices; fibrin-ferment is set free; coagulation takes place; and the injured part is converted into a semi-solid mass of dead albuminous material, of itself perfectly inert. If the irritant is not sufficient to produce the full effect and kill the tissues, the changes are probably the same in direction, but are not carried so far.

The effect upon the blood-vessels is of exactly the same character. At first, unless the irritant is a very powerful one, there is a momentary contraction of the arterioles and capillaries, but this is not constant, and is probably not important. As soon as its influence fairly reaches the muscular fibres, and the endothelial cells that form the walls, the tonic contraction relaxes, the vessels dilate, and the part becomes loaded with blood. For the first few moments the speed of the stream is slightly increased, owing to the capillaries not dilating to the same extent as the arterioles, but this does not last long. Some of the living cells are killed or badly hurt; the normal relations between the blood and the walls of the vessels no longer hold good; the colourless corpuscles, which always have a tendency to lie on the outside of the current, accumulate in greater numbers and cling more closely to the damaged structures; they stick for a time at one spot, and when they do move seem as if they were being dragged away; and many of them pass through the wall and collect in the interstices around. Then the plasma becomes more viscid; the stream becomes slower and slower; the red corpuscles in the axis oscillate a little, and finally come to a standstill altogether. In other words *stasis* sets in. The circulation stops; the part is full of blood, and after a time *thrombosis* occurs, coagulation taking place in the vessels as well as in the tissues.

The injury has lowered the vitality of the cells that line the vessels and form their wall; and now they act towards the blood like any other dead or dying structure. The changes are the same as in the tissues; the blood ceases to circulate in the one, and the plasma in the other; some of the cells are killed; the ferment is set free; coagulation takes place; and fibrin is formed, only, owing to the presence of red blood-corpuscles in the one, the appearance is much more striking and more easily recognised than in the other.

Such an effect as this may be produced by any simple kind of injury, mechanical, physical, or chemical. A bruise kills some of the subcutaneous tissues and causes a slight extravasation of blood; a clean incised wound, the edges of which are at once brought together again, does the same. The actual cautery, plunged, for example, into a nævus chars some of the tissues round, and for the time impairs the vitality of those farther off. A ligature tied tightly round the stump of an ovarian tumour stops the circulation through it mechanically and leads to the same result; and, on a larger scale, the same thing occurs in one form of senile gangrene; the tissues are slowly starved to death, and the part gradually becomes hard, and mummified.

The subsequent changes, always provided no other irritant is allowed to appear, are equally simple.

I. The tissues that are killed either undergo fatty degeneration, or are dried up, according to their position. In the former case they gradually disappear, being absorbed by the living structures around; in the latter, the deeper part may be absorbed, but all the hardened structures are thrown off, a new layer of epidermis being slowly developed beneath them, so that the surface is once more restored.

II. Those around that are only slightly injured recover by degrees and begin the process of repair. For this, however, the general nutrition must be fairly good; if their vitality is already low, not only is the extent of the original injury far greater than it otherwise would be, but they may not have sufficient power to rally, and then the area of destruction spreads.

Repair.—The way in which this is carried out is merely an expansion of the natural process of nutrition. All the interstices of the tissues, every where, are filled with plasma, which pours out through the walls of the blood-vessels, on the one hand, and drains off by the lymphatics, on the other. Each living cell draws from the general stock around it what it requires for itself, and gives up that for which it has no further need. When it is worn out, or when, from injury or any other cause, it is brought to an untimely end, it is quietly removed and replaced either by the development of fresh ones from the survivors near, or by the agency of the leucocytes which wander freely through the channels. The rapidity of the current is regulated by the amount of work to be done. Where the activity is unusually great, and the amount of work exceptional, as after an injury, the plasma pours through more freely, the blood-vessels dilate, the blood circulates more rapidly, more food is brought, and the waste is removed more quickly. If, on the other hand, a part of the body is kept at rest and does no work, whatever the cause may be, the plasma remains stagnant and the tissues starve.

If the injury has been a slight one, not sufficient to kill any of the tissues, perfect restoration is the rule. The red blood-corpuscles separate from each other and fall off into the circulation, almost, if not quite, unchanged ; the endothelial cells recover their natural tone ; the vessels regain their calibre ; the plasma loses its viscid character, just as incipient rigor mortis may pass off, and the colourless corpuscles cease to collect against the wall or pass through in excessive numbers.

If it has been more severe, so that some of the tissue-elements and of the cells in the walls of the vessels are killed (with or without extravasation), and the plasma has coagulated, the process is not so simple ; a certain amount of new tissue must be formed, to replace that which is lost. The injured area now is transformed from a living part of the body into a mass of dead and dying cells, held together by a network of fibrin. The circulation has ceased, the capillaries are plugged, and sometimes, owing to the giving way of their walls, the interstices are filled with blood. Such a condition as this occurs after every bruise, and on the surface of every wound, even if the edges are brought together at once, the lymph forming a soft but tenacious clot which helps to check the hæmorrhage and glue the parts together until permanent repair is effected. This is carried out mainly, if not entirely, by the leucocytes.

Normally in all the tissues there is a certain proportion of free corpuscles wandering in the plasmatic canals, removing what is broken down and perhaps replacing it. After an injury, especially one of this severity, these increase immensely in number, pouring through the walls of the vessels and spreading into all the spaces round. In the centre of the injured area, where stasis has occurred, this, of course, is only possible to a slight extent ; but all round, where the tissues are only slightly hurt, and farther away, where they are not hurt at all, but only stimulated to increased exertion by the presence of injured structures near, these leucocytes pour out in myriads, removing and replacing what is dead, and advancing (eating their way in reality) farther and farther towards the centre, until the whole injured area is transferred into a mass of living corpuscles.

In the case of small extravasations, this transformation is most conspicuous. At first there is merely a dark-coloured clot of fibrin entangling the red corpuscles and a few of the white ones in its meshes ; the serum drains away and is carried off by the lymphatics. Then the red corpuscles undergo disintegration ; the colouring matter soaks out of them and stains all the tissues near, the *débris* and the fibrin remain behind. Soon the outside of the clot is perforated by numbers of living leucocytes, many of which may be seen to contain fragments of coloured ones in their interior. Gradually this change extends farther and farther towards the centre, until by degrees the whole mass is consumed, and nothing is left but the leucocytes which have replaced it.

These changes are not without their effect upon the parts around. More work has to be done; a greater amount of blood is required, and consequently all the neighbouring vessels dilate, the temperature of the part is raised, the skin is reddened if it lies near the surface, there is a certain amount of tenderness on pressure, and a certain degree of swelling caused not only by the extravasation, but by the increase in the quantity of the blood and the circulating plasma that the part contains. Further, the quantity of waste and dead material to be absorbed is larger than usual, and, as a consequence, the temperature of the whole body is slightly raised, for there is evidence to show that the ferment set free when the tissues undergo disintegration acts upon all the heat-producing centres. All the nutritive changes, in short, are carried on with more than the usual degree of energy.

The next step is the formation of fresh blood-vessels. It is possible that when the injured area is exceedingly small, the leucocytes may derive sufficient nourishment from the circulating plasma; but if it is of more than the most minute dimensions, and new vessels are not formed, the young cells near the centre starve and undergo fatty degeneration. In all cases they develop from pre-existing capillaries. Conical processes spring from the walls, and grow out among the masses of leucocytes, until they join other processes or other vessels. At first they are solid, but even while they are growing a hollow makes its appearance at the ends, and gradually spreads farther and farther until there is a minute central canal down the whole length. This enlarges sufficiently to admit the red corpuscles; then nuclei appear in the wall; and a perfect capillary is formed, ready itself to become the starting-point for others, until the mass of growing leucocytes is supplied with loops of vessels, spreading into it from all sides and converging towards the centre. This is known as *vascular granulation-tissue*, from the peculiar appearance it presents when it is formed upon the surface of a wound exposed to the air; by it, all the broken-down tissue and extravasated blood are removed, and from it is developed the newly formed tissue which is to replace the old.

Many of the corpuscles of which it is composed closely resemble pus-corpuscles, and probably, like them, are dead. They are round, motionless, slightly granular, with a bifid or trifid nucleus, which becomes more distinct on the addition of acetic acid. These disappear, very possibly consumed by those around. The living ones are larger, with clear oval vesicular nuclei, and, from the resemblance they bear to epithelial cells, are sometimes called epithelioid.

Organisation always begins near the normal tissue, where the effect of the irritant is scarcely felt. The living cells enlarge, become spindle-shaped or branched, and range themselves in bundles alongside or round the vessels (*fibroblasts*); then their borders and ends become fibrillated, other fibrils make their appearance in the matrix between them, many of the nuclei disappear, others persist as small oval corpuscles, and a little mass of fibrous cicatricial tissue is formed, abundantly supplied with vessels. A few multinuclear giant-cells may generally be found, formed either by the division of nuclei without proportionate partition of the cell-body, or by the blending and coalescence of contiguous corpuscles. When the process is very chronic and the vessels few in number, as in the case of infection with tubercle, the tendency to their production is very much greater.

The process of organisation after a single injury gradually extends through the whole thickness, beginning at the circumference and converging towards the centre, until the whole area of granulation-tissue is transformed. If the injury was an open wound, modifications naturally take place for the production of a protecting layer of epithelium, but this will be dealt with later. The newly formed tissue at first is highly vascular; by degrees, however, the bundles of fibrils contract more and more, and obliterate the vessels to a great extent. In simple injuries the amount is always small—the minimum, in fact, required to remove and replace what is dead, and the degree of contraction is never serious. When, on the other hand, the tissues have been extensively destroyed by suppuration, the quantity may be so great, and the tendency to contract so inveterate, as to cause the most serious deformity.

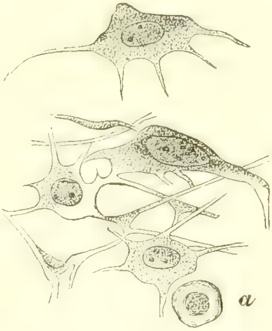

FIG. 1.—A group of fibroblasts in different stages of growth. *a*, embryo cell wandering. (After Golding Bird.)

THE EFFECT OF CONTINUED IRRITATION

A transient irritant, not sufficiently severe to kill the tissues, after its first effect has subsided, acts as a stimulus on all the structures round; they begin at once to act with greater energy, and strive their utmost to repair the damage that has been done. The same thing occurs when the irritant is a persistent one—the tissues throughout keep doing their best to repair the injury inflicted on them; but there is this great difference, that in this case the irritant, instead of being a thing of the past, is hard at work the whole time, sapping the vitality of all the structures near, and diminishing their power of resistance. The whole time the irritant continues there is a contest between it, on the one hand, and the tissues on the other. These, by increasing the amount of the exudation that pours out through the walls of their vessels, keep striving to repair the damage already done, and to check the progress of the injurious agent, whatever it may be; while this, so long as its power lasts, is engaged in destroying the exudation, weakening the tissues and impairing their vitality. The sum of the changes produced in the conflict is known as inflammation; as soon as the irritant ceases to act inflammation ceases and repair begins.

SYMPTOMS OF INFLAMMATION

These are the same as those already described, but they are very different in degree. Redness, heat, swelling, and pain are present, as before, to a greater or less extent; the functional power of the part is lowered; and the temperature of the blood is raised; but this is no longer within physiological limits; now the changes are pathological, kept up by an irritant which is all the while at work, either impairing the vitality of the tissues, and causing inflammation, or killing them.

In inflammation of a superficial part all these signs are usually present and equally well-marked, and the diagnosis is clear; in other cases, however, especially when the part is deeply seated and the irritant of low intensity, there may be only one, and then the difficulty is very great. In such, a diagnosis can often be made only by a process of exclusion, or by actual exploration.

Redness.—The colour may be brilliant, returning instantaneously if driven away by pressure, or livid and almost purple, as round the margin of old sinuses. In severe cases the blood-vessels give way, leaving ecchymoses, which after a time (especially if they are repeated) turn a dull red-brown. A pigment-stain produced in this way lasts for years, particularly when it is upon the legs. If, as in periostitis of the femur, the inflamed part is deeply seated, the colour of the skin remains unaltered, or is even whiter than natural, from being stretched by the effusion beneath.

Swelling is never absent, although if the part is thickly covered in it may not be detected. At first it is due simply to the distension of the vessels; but this is insignificant in comparison with the exudation that follows. The rapidity with which it forms and the degree of firmness it presents to the touch, depend upon the anatomical arrangement of the tissues and the character of the exudation. The more open the tissue, the more quickly it takes place and the softer it feels. Structures, therefore, like the eyelids or scrotum easily assume enormous dimensions. On the other hand when the exudation is bound down beneath a layer of dense and close fibrous tissue, such as the periosteum or the deep cervical fascia, it may be, for a time at least, as dense and resistant as bone, although if firm pressure is used it will always yield a little, forming a sharply defined pit which slowly fills up again.

The character of the exudation varies with the nature and intensity of the irritant. It may be *serous*, with but few leucocytes and little tendency to form fibrin—almost the same, in short, as that which is present in health; this is chiefly met with when the cause is a distant one—round the extreme margin of an abscess, for example. It may be *sero-fibrinous* or *fibrinous*, consisting of little but a meshwork of fibrin formed from the plasma and enclosing the leucocytes in its meshes. Or it may be *sero-purulent* or *purulent*, when, owing to the peptic action of pyogenic micro-organisms, no fibrin at all is formed, but only a mass of albuminous liquid, with dead and dying pus-corpuscles floating in it. Distinct examples of all of these are seen in serous and synovial cavities, but they are of frequent occurrence elsewhere, especially in the meshes of connective tissue.

When the irritant is very intense, the walls of the capillaries perish, and the exudation becomes *hæmorrhagic*. When, on the other hand, it is slight but persistent, as in the case of tubercle and syphilis, masses of *granulation-tissue*, with giant and epithelioid cells, are developed. Sometimes, after lasting a considerable time, this becomes absorbed: more frequently, according to the cause, it either becomes organised, undergoes degeneration and caseation, or breaks down into pus. From this peculiarity these diseases are sometimes known as infective granulomata, granulation-tissue being produced in masses of such size that they resemble tumours.

A so-called croupous or diphtheritic exudation is occasionally met with upon the surface of granulating wounds. It forms a buff-coloured rind, which may be peeled off easily, leaving a raw surface, which usually heals readily if brushed over with nitrate of silver or iodine. Sometimes, however, it is reproduced again and again, and it may extend, to a serious degree, especially on burns. Probably it is due to coagulation-necrosis, caused by the action of certain germs, involving the exudation and, in the diphtheritic form, the tissues themselves sometimes to a considerable depth. True diphtheria very rarely attacks wounds ; when it does it is usually caused by direct infection (though, curiously enough, tracheotomy-wounds are seldom contaminated), and the clinical symptoms and sequelæ resemble those of the ordinary form, allowance being made for the difference in locality.

Heat.—The temperature of an inflamed part is nearly always raised : the only exceptions are the very chronic cases (and in these it is probable that a thermopile would detect some slight variation at one time or another) ; and some of the very acute, in which, owing to the early occurrence of stasis, the current of blood flowing to the part is greatly reduced—in short, in incipient gangrene. It is stated to be due, not to the increased local production of heat, but to the increased supply of arterial blood raising the temperature of the part almost to that of the interior of the body. Of course this may be far above the normal. Care must be taken, when estimating the temperature of any part, to compare it, not with the normal temperature of the body, but with the actual temperature of the corresponding part, placed under exactly the same conditions of clothing and exposure.

Pain.—The severity depends upon the degree of tension. In acute inflammation of tough fibrous structures, or where, as when bone is concerned, there is great resistance to expansion, it is exceedingly severe, and is made infinitely worse by anything that increases the current of blood in the part—allowing it to hang down, for example, or using it in any way. Under these circumstances, especially when suppuration is imminent, it is often described as throbbing, each throb corresponding to a beat of the heart, and to a fresh amount of blood driven into the part.

The character of the pain depends more upon the tissue concerned ; thus bones and ligaments ache ; the skin smarts and burns ; and the eyes become intolerant of light. In very severe cases the pain may cease altogether towards the end, owing to the failing power of the brain.

Impairment of the function of the part is often one of the most valuable signs ; an inflamed joint, for example, is held rigid by the muscles, and cannot be moved to its full extent in any direction. In the same way absorption and secretion cannot be carried out if the mucous membrane of the bowel is inflamed, and peristalsis is stopped if the serous and muscular coats are attacked. All work increases the amount of blood in the part, causes varying degrees of tension to fall upon the tissues, and makes the pain and inflammation more severe.

Fever.—In addition to these local signs inflammation is always attended by a certain degree of fever. The temperature of the body, which normally ranges from 97·5° to 98° in the early morning, to 98·5° and even 99° of an evening, is raised ; the pulse is quick and hard ; the respiration is hurried ; the tongue and mouth are dry ; the appetite is lost, and all the secretions are diminished. The skin is hot and parched, the urine is scanty and high-coloured, and the bowels constipated. Sleep is disturbed ; headache is always present ; delirium is usual (especially at night) when the temperature is raised more than three or four degrees, and the loss of flesh and strength is rapid and extreme.

The cause of this fever is mainly the increased production of heat; in comparison the diminished loss by the skin from the absence of evaporation is altogether insignificant, and this increase results from a greater degree of activity in the metabolism of the parenchymatous tissues of the body, the muscles and glands in particular. So much is clear from the rapid emaciation and loss of strength, and from the increase in the amount of carbonic acid and urea eliminated.

The way in which this increased metabolism is brought about is not so clear or so definite. In all probability the changes that take place in the tissues are under the control of the nervous system; it seems likely that the supreme centre is in the cortex of the brain, probably in the parietal region; that there is another in the medulla oblongata; and, as in the case of the vasomotor system, others still—subsidiary ones—in the spinal cord. Possibly also, carrying the analogy further, the tissues themselves are not altogether devoid of influence, at any rate when isolated from the main command. In fever it is believed that this control over the metabolism is enfeebled, and that the tissue-changes are carried on at a much more rapid rate, with, as a natural consequence, increased production of heat. This undue activity of the metabolism is in some cases excited by peripheral stimuli; tension, for example (even such an apparently trivial matter as a suture drawn too tightly), is undoubtedly a very powerful stimulus, although it must not be forgotten that it helps as well by promoting the absorption of fever-causing substances from the tissues. Mental emotion is another, and possibly this explains some of the mysterious cases of local hyperpyrexia. By far the most powerful cause, however, is the absorption, through the blood or through the lymphatic system, of certain products which either weaken the control of the nerve-centres that preside over metabolism, or stimulate the tissues to increased change. In other words, pyrogenous agents, as they are called, act either directly or reflexly upon the heat-regulating centres in the central nervous system, impairing their power of control; or upon the tissues themselves, stimulating them to increased activity.

Of substances that possess this power there is no lack. Broken-down blood-clot, even when a wound is subcutaneous, is one, the active constituent being, so it is said, the fibrin-ferment. The products of putrefactive fermentation possess it in a very much higher degree, causing septic traumatic fever or sapræmia, according to the nature of the ptomaine produced, and the quantity that enters the circulation at once. Many varieties of infective germs are still more active, multiplying in the tissues and the blood-stream, and forming substances which cause the most severe constitutional symptoms; and in all likelihood the fever that accompanies simple inflammation (not due to putrefaction or to any infective germ) is mainly caused in the same way, partly by tension, but chiefly by absorption through the lymph-stream of substances produced in the tissues under the action of various kinds of irritants.

The character and severity of the fever depend upon the cause. Age is of some influence, as during childhood, when the metabolism of the tissues is most active, sudden and severe attacks are not uncommon after very slight causes. Sex, and what is known as temperament, may also have a certain effect. In the chronic forms of inflammation it is very slight; in acute ones it may be *sthenic*, *asthenic*, or *irritative*.

In the sthenic form the symptoms are acute, the temperature high, 104° or 105° F., and the pulse full, strong, and bounding. The onset is usually sudden, and often marked by a shivering fit or rigor, or, in the case of children, by an attack of vomiting or convulsions.

The asthenic may either succeed to this, or may commence as such, quietly and insidiously. Sometimes it is attended with sloughing, but in many cases the local signs are very slightly marked. From the first, what are known as typhoid symptoms set in ; the patient lies overcome with stupor, or in a condition of low muttering delirium ; the skin is hot and dry ; the face dusky and pinched, with sunken eyes ; there is sordes on the lips and teeth ; and the tongue is dry and brown, or red and cracked. Diarrhœa is often present, the motions being passed unconsciously; and frequently there is albuminuria. The pulse is small and quick, and the respiration hurried and shallow, but the temperature is rarely very much raised, and it may even be subnormal, especially towards the end. This variety is only met with where the patient's health is utterly broken down from intemperance or other causes, or where an irritant poison is absorbed in overpowering quantity, as in septic peritonitis following operation.

Irritative fever is less well-marked ; one chief characteristic is the early occurrence of delirium, and the prominence of the nervous symptoms.

The fever is said to be *continuous* when the daily variations do not exceed 2° F. ; if it is greater than this it is called *remittent*. In the *intermittent* form there are periods (which may or may not be regular, and which vary greatly in duration), during which the temperature does not rise above the normal.

Varieties of Inflammation

These are the signs common to all forms of inflammation ; they are an indication of the changes that take place in the living tissues while they are being irritated by some cause not sufficiently powerful to kill them, and they occur in all alike, so far as structural conditions allow. In part they are the direct effect of the injury lowering the vitality of the tissues upon which it is acting ; in part they are due to the efforts at repair made by the living (uninjured) elements around ; if the irritant is the stronger, destruction progresses more or less rapidly, and the fever is high, and the part red, swollen, and painful ; as its influence begins to wane and the tissues gain the upper hand this diminishes, and when its action ceases, the fever and the other signs disappear altogether ; there is nothing then to hurt the tissues further, or prevent them regaining their former activity, all pathological changes come to an end, and the natural process of repair (which has been doing its best all the time) now is able to make headway, and remove all trace, so far as is possible.

The extent of the changes in inflammation depends upon the condition of the tissues on the one hand, and the intensity of the cause on the other. The character depends upon the nature of the irritant.

A very trivial injury, for example, may give rise to the most serious consequences if the nutrition of the tissues is enfeebled from disease or intemperance ; but mechanical irritants can only cause simple inflammation; suppuration cannot occur without pyogenic organisms, and tubercle cannot break out without its specific bacillus. The tissues, in their endeavour to limit the action of the irritant, always produce the same exudation, but the changes this undergoes under the influence of different irritants, and under different conditions, naturally differ and give rise to different descriptions of disease.

Simple Inflammation

The causes are mechanical, physical, or chemical irritants, sufficiently severe to injure the tissues without killing them outright; a suture, for example, drawn too tightly, a burn or scald exposed to the air, constant friction, or long-continued irritation by dust or smoke. The symptoms are those described already: pain, heat, swelling, and redness, with impairment of function and fever, varying according to the size and importance of the part involved, and the acuteness of the attack. They may be so intense as to endanger life, or so slight as to be scarcely perceptible.

Simple inflammation may end fatally, or undergo resolution, or become chronic. The exudation may become absorbed, organised, or undergo fatty degeneration. Suppuration is a complication due to the action of certain micrococci.

(*a*) *Death* may be caused by the intensity of the fever, by exhaustion, or by the organ that is attacked being essential to life, as in the case of the glottis or the heart.

(*b*) *Resolution.*—If the nutrition of the part is good, this begins as soon as the cause is removed. The pain and fever cease; the temperature of the part, although still above that of the corresponding one, owing to the amount of blood it receives, is well below fever heat; the swelling disappears, except so far as it is caused by the increased flow of blood and plasma necessary for repair; and the redness loses its angry tint, although the blush persists for many months if new vessels have been formed. The amount of granulation-tissue and scar-formation depends upon the extent of the disease. It may be so little as to be practically imperceptible, as after a bruise or a simple incised wound, or it may be of any extent.

(*c*) *Persistence.*—If the cause is frequently repeated, or if, without being too severe, it continues to act, the inflammation persists and is very liable to become chronic. This is especially likely when constitutional predisposing causes, such as gout and rheumatism, are present; the attack commences with some slight irritant such as would not be noticed if the tissues were healthy, and the morbid state of their nutrition is sufficient to prevent resolution after the original irritant has ceased to act.

General Principles of Treatment

Inflammation is the result of an injury sufficiently severe to impair the vitality of the tissues without killing them outright. The first thing, therefore, is to prevent, as far as possible, the access of any irritant (preventive treatment), and the next, to remove any source of injury that may be present, to strengthen and maintain the nutrition of the tissues, and to place them under the most favourable conditions for resisting and overcoming anything that affects them injuriously.

1. *Preventive*

A single uncomplicated injury is not followed by inflammation; the process of repair begins at once, and if there is no other irritant and the damage is not too extensive, is completed without the surrounding structures suffering in the least. Inflammation is the result of continued irritation—either local, such as that caused by the presence of foreign bodies, by tension, friction, want of rest, or putrefaction; or constitutional, resulting from some morbid condition of the blood or tissues, as in gout. The preventive treatment, therefore, except in so far as it is possible to improve the nutrition of the tissues and place them in a more favourable condition, practically resolves itself into the treatment of wounds and other injuries.

2. *Curative*

1. **Removal of the cause.**—Foreign bodies must be removed; tension relieved by dividing sutures, making incisions, and providing the freest possible drainage; and friction prevented by absolute rest. Pain must be allayed, and any irritant in contact with the surface, whether it is an overpowerful antiseptic or the products of putrefaction, either removed or rendered innocuous. Sometimes, when the inflammation is due to the action of a powerful local irritant, as in phagedæna, the surface must be destroyed, and occasionally certain drugs are employed which may possibly act directly upon the cause—mercury, for example, in syphilis, and colchicum in acute gout.

2. Where the cause cannot be removed, the symptoms must be treated. In other words, an attempt must be made to regulate the quantity and quality of blood flowing through the part, so that the nutrition of the affected tissue may be maintained as well as possible.

The means at disposal are local and constitutional.

Local Remedies

Rest.—The more the part is used, the greater the amount of blood flowing to it and the greater the tension. To be of any use, however, the rest must be complete.

Position.—The effect of allowing an inflamed limb to hang down is well known. Raising it assists the venous and lymphatic circulation, and at the same time lessens the amount of blood entering it, by causing a vaso-motor constriction of the arteries.

Pressure.—Uniform, gentle, and elastic pressure, such as that produced by investing the part with many thicknesses of cotton-wool, and then placing a bandage over the whole, is a most efficient method for diminishing pain and tension even in cases of phlegmonous inflammation. In a few instances pressure has been applied to the main artery of a limb with the same object, and the femoral has been ligatured in cases of acute inflammation of the knee-joint.

Cold is a most powerful agent for checking the amount of blood flowing through a part. It may be applied either by means of an icebag, or by Leiter's coils of leaden tubing, arranged to fit closely round. In other cases, lead and spirit lotion is allowed to drip slowly over the part and evaporate, the surplus being carried off by means of properly arranged rubber sheets beneath. It checks protoplasmic movement, lowers the vascular tension by causing paralytic dilatation of the walls of the smaller vessels (at first there is a temporary constriction), and if applied continuously and with sufficient vigour, can stop the circulation altogether. In some cases, as for instance with tubercle-bacilli, it possesses the power of retarding development, but, at the same time, when carried far enough for this, there is great danger of its depressing the vitality of the tissues too. It may always be used in the early stages of inflammation, and very often throughout in the sthenic form, especially when the local symptoms are well-marked (as, for example, in quinsy) with a view of limiting the hyperæmia and, if suppuration occurs, reducing the size of the abscess; but in the asthenic form it should always be avoided. An icebag laid along the course of the main artery at a distance from the seat of inflammation is sometimes of considerable value.

Warmth acts in the opposite way; it stimulates amœboid movements, causes the walls of the vessels to dilate, and gives freer passage to the blood. Applied to the spot itself it diminishes the tension in the tissues, and in the early stages may procure resolution; but if suppuration is imminent it only encourages it. Advantage is taken of this when it is wished to make an abscess point. When used over a more extensive surface, it diverts a larger portion of the blood that would otherwise flow through the inflamed area, and, by relaxing the tissues, facilitates the return through the veins and lymphatics.

Whether heat or cold should be applied locally may be left, to some extent, to the patient's feelings, but not altogether. The former is usually selected, as it diminishes tension and pain more quickly; but if the latter is continued for a little time, especially when the inflammation is acute and sthenic, the relief is, generally speaking, much more complete. Whichever is chosen, the application must be continuous; any intermittence, especially in the case of cold, makes matters infinitely worse.

Astringents are chiefly used over the surface of mucous membranes. Lead, however, if applied to the skin for any length of time, becomes absorbed (as shown by the discolouration) and acts directly upon the capillaries and small vessels.

Local bleeding in acute inflammation is of the greatest service, although it is very difficult to explain why. It cannot be the amount withdrawn, for this is usually altogether insignificant. Leeches may be used (not, however, over any loose tissue, such as the eyelid or scrotum; in orchitis they must be placed on the groin); superficial veins may be punctured; or small incisions made here and there in the axis of the limb, taking care to avoid any important structure. The last method is especially useful in phlegmonous inflammation of the cellular tissue, when there is any danger of sloughing, to relieve the tension on the skin. The bleeding may be encouraged afterwards, if necessary, by means of a warm bath.

Wet-cupping is rarely practised now; but dry-cupping may be employed with benefit in inflammation of deep-seated organs such as the kidneys. The air in a cupping-glass is rarefied by holding it like a bell over a large spirit-lamp, or by burning a small quantity of spirit inside, and then the mouth is quickly pressed against the skin, taking care not to burn the patient. As the air condenses, the tissues rise up in a convex dome, partly filling the cup, the cutaneous vessels become distended, and many of the smaller ones rupture.

Counter-irritants.—Rubefacients, blisters, Scott's dressing, and the actual cautery are chiefly of use in the chronic forms. In all probability they act reflexly upon the deeper vessels, as the mere local dilatation and exudation can have but little influence. Belladonna (the extract mixed in varying proportions with glycerine) is sometimes applied with benefit over very large areas. There is no fear of too great absorption through the skin, but abraded surfaces must be avoided. It causes a slight temporary constriction, but this is soon succeeded by a more permanent dilatation, lowering the tension and relieving the pain.

Constitutional Measures

Diet is of great importance. The waste in all forms of inflammation is very rapid, and at the same time the appetite and the power of digestion are very much impaired. Solid food is out of the question in acute cases. Light diet, milk, beef-tea, arrowroot, and other farinaceous foods, jelly, milk-puddings and the like, are sufficient in cases of sthenic inflammation of short duration. If, however, the attack lasts any length of time, or if, as in erysipelas, the area involved is extensive, the strongest meat-jelly, eggs beaten up with milk, brandy and egg mixture, peptonised foods, and similar substances that are easily absorbed, must be given in small quantities at frequent intervals, even when the patient is young and was previously healthy. In older people, and those whose health is broken down, nourishment is still more imperative ; and it is then that stimulants are of such value, enabling the patient to make the most of what is taken with the least exertion. Great care, however, is required not to overdo it.

Fluids are given throughout as required. Fragments of ice may be sucked from time to time, to allay the parched condition of the mouth, but it must be remembered that a considerable quantity of water is swallowed in this way. Barley water, lemonade, and acid fruit drinks are often very grateful, and, in moderation, do no harm.

In the more chronic cases—in tubercular inflammation of joints, for instance—a great deal may be done towards improving the quality of the blood, and the general nutrition, by means of good food, fresh air, tonics, and especially cod-liver oil. Sea-air in these cases is often of wonderful benefit, enabling the tissues to make head against the action of the irritant until a less susceptible time of life is reached.

Bleeding is rarely practised, although sometimes in cases of acute suppurative arthritis, or in pneumonia, when the other lung is becoming engorged, it is of great use, especially in young adults, the fever falling at once. In children or patients past middle life, its ultimate value is very doubtful, although it may appear to help in tiding over a crisis.

Purgatives.—In inflammation the bowels are nearly always confined, and their action is followed by great relief. If the mucous membrane of any part of the alimentary canal is involved, of course this is different ; but in incipient peritonitis, with effusion, mild purgation has recently been strongly advocated. It must be remembered that the patient, as a rule, is taking only a small amount of food, and that of such a nature as to leave little residue, so that the constipation may be to some extent apparent rather than real.

Aconite (one minim every five minutes until a distinct effect is produced upon the pulse) and antimony (given at frequent intervals until it causes nausea) are sometimes given in young subjects at the commencement of an acute attack (when the heart is sound) with a view of producing general vascular depression. The latter drug is also used in smaller doses during the course of the fever, for the sake of its action upon the skin, and is frequently given for this purpose in conjunction with Dover's powder. Opium is often required internally as well as locally, for the relief of pain or to procure sleep ; chloral, bromide of potassium, and sulphonal are chiefly of use as sedatives or hypnotics. If the temperature is very high, quinine, antipyrin, or salicylic acid is advisable, and the first named appears to possess the power of checking an incipient rigor. In hyperpyrexia cold-sponging, an icecap (Leiter's coils, arranged so as to fit the head, form the most convenient appliance, although a simple icebag made of thin rubber may be used) or even an icepack may be required; but meanwhile, and for some time aftewards, close watch must be kept upon the pulse, as sometimes, in these cases, the cardiac muscle fails rather suddenly.

In some cases of high temperature alcohol has been given with considerable benefit. The condition of the pulse and of the heart is in general the best guide to its administration. It is not required in sthenic inflammation of short duration in young subjects; but in asthenic forms attended with sloughing and great depression, especially in old people, it must sometimes be given very freely to tide them over a critical period. In smaller quantities it is of great service in assisting digestion and enabling the patient to make the most of his food with the least expenditure, particularly during convalescence. Carbonate of ammonia in five-grain doses is especially useful when the tongue is dry and brown and the pulse is beginning to fail in strength and volume. Ether may be given at the same time. Mercury is used, and with benefit under many different conditions; as a purgative at the commencement of an attack; as an alterative, particularly in children in the form of hyd. c. cret.; in all stages of syphilis, more especially the early ones; and locally, sometimes, as a counter-irritant. Colchicum, alkalies, iodide of potash, salicylate of soda, and other drugs are of benefit in special cases; and tonics, especially iron, quinine, and cod-liver oil, are usually required during the period of convalescence.

Chronic Inflammation

Acute inflammation may become chronic merely from frequent repetition, even when the tissues are healthy and without predisposition of any kind. Each time, for example, a loose cartilage is caught between the bones of the knee-joint, it gives rise to an attack of synovitis; before the first one the tissues may have been perfectly healthy, and if it is the only one they may recover completely; if, however, the injury is constantly being repeated, so that there is no time for perfect repair, organic changes are left, nutrition is permanently impaired, and the synovitis becomes chronic.

Constant friction acts in the same way; the conjunctiva, for instance, becomes roughened and granular; the neck of a hernia hard and dense as cartilage; and even the skin may be entirely altered in texture. In the same way the mucous membrane of the throat, instead of remaining soft and flexible, becomes covered with irregular elevations, and seamed with superficial cicatrices as a result of persistent chemical irritation of slight intensity.

Chronic tension leads to a similar result. A leg in which the veins or lymphatics are obstructed slowly increases in size, and becomes affected by what is known as solid œdema, from the resistance it offers when pressed by the finger. The exudation becomes organised; the amount of lowly developed fibrous tissue increases; the muscles waste; the skin is thickened, bound down, and hard, and at length a condition practically equivalent to elephantiasis is produced.

Predisposing causes are of especial importance in connection with chronic inflammation. If they are strongly marked an acute attack is almost sure to become chronic, whether the exciting cause is repeated or not. A single abrasion, for example, is sufficient in the case of a leg which is congested from long-standing venous obstruction. The skin is badly nourished; in certain places—just above the ankle, for example—it is scarcely able to hold its own; if the cuticle is rubbed off, or a tiny vein gives way, or, in short, if there is the least injury, such as in any other part of the body would not attract attention, inflammation sets in, the already weakened cells and fibres perish, and then, because of the presence of these dead structures, or the friction of the clothes, or the tension due to the very slight addition of blood to the part, it becomes chronic. The least cause is sufficient to depress the vitality of the tissues around and to prevent resolution.

In gout and rheumatism, which are among the most common causes of chronic inflammation, the conditions are much the same. In each the nutrition of the tissues is so gravely involved that a very trivial cause gives rise to an acute attack, and sometimes the predisposition is so strong that an exciting cause is scarcely needed. At first, the attacks subside and recovery is, to all intents and purposes, complete. After a time, however, the reparative power of the tissues becomes more and more impaired, the natural condition is never regained, and the inflammation becomes chronic. The predisposing causes have grown so strong that they are not only able to originate an attack with the very slightest assistance, but to maintain it too.

Symptoms.

The general symptoms are the same as in acute inflammation, but much less severe. Increased heat is often scarcely to be detected; the redness is always slight, although brown discolouration from long-standing hyperæmia is often present, especially upon the legs, where gravity favours stasis; and the pain more frequently takes the form of a continuous wearying aching, with every now and then a more severe spasm; but even when suppuration occurs it never assumes a tense, throbbing character. In the same way the fever is slight, and the loss of function much less noticeable, partly no doubt because other structures compensate for it, and the patient has had time to become accustomed to it.

With swelling, however, the case is different. Exudation is always present, but only a small proportion of it is fluid; nearly the whole is composed of organised elements, many of them escaped leucocytes, but many more developed from the living cells in the tissues round. Whatever may be the case in acute inflammation, whether or no the tissue-elements take any share then in the production of the exudation, in the chronic form there is no doubt they do, and to a very considerable extent. Sometimes the part is greatly increased in size; but not unfrequently, owing to retrogressive changes, its bulk is actually diminished; either the exudation, after replacing the natural structures, itself undergoes degeneration and disappears, or it becomes organised into a lowly developed form of cicatricial tissue, which contracts, strangling the natural structures, and rendering the organ it infiltrates hard, dense, irregular, and contracted.

Organisation is the prominent feature of the chronic inflammation that occurs in rheumatism. The articular ends of the bones are covered with dense irregular nodules; the shafts in some cases are immensely thickened and hardened; the fibrous tissue round the joints is toughened and rigid, and a similar change is met with in connection with the nerves, the walls of the arteries, and, in fact, any connective-tissue structure that is attacked.

In chronic gout the ultimate effect upon the exudation is complicated by the addition of deposits of urate of soda.

In some of these affections, in which the prominent feature is an immense overgrowth of the connective-tissue type, unaccompanied by pain, increased temperature, or fever, it is exceedingly difficult to draw a distinction between chronic inflammation and hyperplasia, especially as the remedies upon which reliance is usually placed here fail completely. Ostitis deformans is an example, and some of those cases in which the lymphatic glands are immensely enlarged without undergoing any definite alteration in structure. It is more than questionable, however, whether an attempt at such a refinement could succeed. In either case there is an impairment of nutrition, resulting generally in increased size, and always in imperfect development of the part, and caused by some morbid condition of the tissues or of the blood. It is not possible to say whether this is to be regarded as the result of an irritant injuriously affecting one particular tissue, and acquired during life; or of some natural impairment born with the individual, and probably transmitted to him from his ancestors.

Treatment.

The principles of treatment in chronic inflammation are the same as in the acute form, but the details vary considerably.

1. **Removal of the cause.**—In some few cases a definite exciting cause can be found and removed: a sequestrum, for example, may be lying locked in the medullary canal of a bone, unable to escape; or a band of lymph may be left tying down the margin of the iris. In the majority, however, the reason, if not for the outbreak, at least for its persistence, is to be found in the presence of some constitutional affection which does not admit of such speedy treatment. Mercury, given in small doses and for a sufficient length of time, may possibly act on the syphilitic virus as a specific, destroying it, or at least prevent it from having any further influence; but very few other drugs possess this power. Iodide of potash, though it will remove the effects, certainly cannot stop recurrences; and the same may be said of colchicum in gout, and the salicylates and alkalies in rheumatism. They relieve the symptoms for the time; the exudation disappears and the pain diminishes; but the cause is too deeply seated in the nutrition of the tissues to be removed in this way.

2. **Improvement in nutrition. General.**—Many of the exciting causes are of very slight intensity; and it often happens that if only the general nutrition can be a little improved, the tissues gain strength enough to deal with the irritant themselves. It is to this improvement, consequent upon the entire change of life and habits, that so many of the foreign bath resorts owe their reputation in gout and rheumatism; and the effect produced does not subside at once.

The particular line adopted varies of course with the complaint. With gout the diet should be sparing and light; stimulants are better avoided, at any rate in the earlier periods of the disease; the bowels should be kept fairly open, and any accumulation of uric acid in the blood prevented as far as possible by abundance of fluid, combined with the moderate use of alkalies. Chronic rheumatism, on the other hand, is chiefly benefited by residence in warm, dry climates; woollen clothing; nutritive but unstimulating food; and the prolonged use of baths, especially sulphur ones, combined with internal administration. Tonics, particularly cod-liver oil and iron, are often of use at the same time to combat the condition of anæmia which is frequently present. By measures of this kind, not only is the immediate attack checked and cured, but the tissues are so built up that they are better able to resist injurious influences of the same character afterwards, in spite of the general rule (which is especially true of this variety of inflammation) that one attack predisposes to another.

Local.—This must be guided very largely by the temperature of the part. Subacute attacks, in which the heat is considerable and the pain severe, should be treated as if they were acute ; but where the temperature is normal, or almost normal, those measures answer best which maintain an increased but uniform supply of blood. Warmth by itself is beneficial, but alternating with cold it produces a much greater effect. Pouring water down from a height, douche-jets, and needle-baths are exceedingly powerful, and are chiefly of use where the inflammation is past and only its effects remain. The same may be said of friction, rubbing, and massage. Carried out efficiently these have immense influence upon the circulation ; the lymphatic spaces are emptied, the effete matter pressed out, the flow of plasma through the tissues quickened, and the nutrition greatly improved.

Counter-irritants are of the greatest use in chronic inflammation, both for the relief of deep-seated pain and the diminution of tension by the absorption of the exudation. Rubefacients, vesicants, and even the actual cautery are employed, according to the depth of the structure it is desired to affect and the duration of the attack. How they act is uncertain, but that the effusion disappears, especially when they are repeated at frequent short intervals, there is no question. Setons, and other methods for causing continued suppuration, are rarely used now.

Mercury and iodine are supposed to possess a special action in promoting the absorption of the products of chronic inflammation ; but, apart from the results they produce as counter-irritants, and in syphilitic affections, it is doubtful if they are not overrated. Iodide of potash, however, has a very considerable effect upon vascular tension. Superficial forms of inflammation —on mucous membranes, for example—are sometimes benefited by the action of local astringents ; and when there is a considerable degree of effusion, as in chronic synovitis, pressure, in conjunction with counter-irritation, may be applied with great advantage.

CHAPTER II

DISEASES DUE TO NON-INFECTIVE ORGANISMS

Of these there are only two, septic fever and sapræmia. Hectic, which is usually included, is in part due to pyogenic germs.

These diseases are caused by the absorption from the surface of a wound of certain poisons produced during the fermentation or decomposition of albuminous liquids. Probably they are ptomaines, analogous to the bodies formed in the alimentary canal. If they enter the blood they act as virulent poisons, the severity of the symptoms depending upon the amount of the dose; and they may cause a fatal result within a few hours. On the other hand, they do not multiply in the blood, which therefore is not infective if it is inoculated; they are excreted slowly and quietly by the kidneys (ptomaines, probably formed in the alimentary canal, are found in the urine and saliva), and if the patient survives the first effect, and the dose is not repeated, the constitutional symptoms gradually subside. There is no incubation period, and, other things being equal, a large wound, or one that exposes a large absorbing surface, such as the peritoneum, is much more likely to be attended with a severe attack than a small one.

Septic Fever.

Subcutaneous injuries, in which decomposition (in the sense of putrefaction) never takes place, are often followed by a certain degree of fever, due either to tension, or to absorption from the seat of injury of some of the products of tissue-destruction, of which the fibrin-ferment is one, and perhaps the most important. It sets in very shortly after the injury, attains its maximum within twenty-four hours, and then, unless some other irritant is present as well, begins to fall again. In addition to this, however, wounds that are exposed to the air are liable to be followed by another and more severe disorder caused by absorption, from the surface, of the products of decomposition.

This does not commence for some days, generally two or three after the injury; then it rapidly attains its maximum, persisting for three or four more; and at the end of the fifth or sixth, if the wound is thoroughly drained, the tissues healthy and well-nourished, and no complication arises, begins to subside again. Naturally, septic fever rarely occurs by itself; in by far the majority of cases it follows the true traumatic fever before this has had time to disappear; and in its turn is followed by that which accompanies suppuration.

At the commencement there is often a feeling of chilliness, but rarely a distinct rigor; nausea and vomiting are not unusual; there is headache, with extreme depression; the temperature rises to 102° or 103° F.; the skin is hot and dry, the face flushed, the bowels confined, and the tongue thickly furred. The appetite is completely lost; the pulse is full and rapid; and, especially in the case of children and people with an excitable temperament, there is often slight delirium at night. The edges of the wound are red and swollen; the skin for some distance round is exceedingly tender and very hot; while the surface, if it is visible, is probably covered over with greyish-yellow sloughs, and discharges a thin, turbid, and somewhat offensive fluid.

Treatment.—The first thing is prevention. If it is too late for this, further decomposition must be stopped, either by irrigation with an antiseptic, or better by placing the part, if it can be done, in an antiseptic bath; but I have known a sloughing wound of the hand remain for three days in a corrosive sublimate bath (1 in 5,000, renewed every three hours) without the smell being overcome.

In addition to this, absorption must be stopped as soon as possible by the most thorough drainage, and by encouraging the wound to secrete. Warm fomentations and warm baths are especially grateful; the tension is relieved; the throbbing pain subsides; the blood circulates more easily; the plasma and the leucocytes pour out more freely through the walls of the vessels; the process of destruction ceases, and a barrier of vascular granulation-tissue is formed, to throw off dead cohering fragments and prevent the absorption of any more of the poison. If the tension is completely relieved, the temperature falls to normal; if, on the other hand, the discharge is retained, it rises regularly of an evening, assuming the remittent type as suppuration follows, and gradually passes into hectic.

Constitutional treatment should not be neglected, but so long as the cause continues at work, it can give but a very small measure of relief.

Sapræmia

Sapræmia, or septic intoxication, is the name given to the most intense variety of septic fever. It occurs under the same conditions, and is caused in the same way, by the absorption from the surface of a wound of some ptomaine formed during fermentation. Probably the particular variety is not always the same, and certainly putrefaction, with the formation of offensive gases, is not necessary. Clinically it is probably very rarely met with by itself; but, like the preceding, it is present as a complication in all extensive wounds, especially those in which a large amount of blood is allowed to accumulate and undergo decomposition exposed to the air.

Substances of a similar character are formed in the decomposition of preserved meats, sausages, and the like, and when swallowed cause all the symptoms of violent irritant poisoning, vomiting, purging, &c., followed by profound collapse, coma, and, if the dose is sufficient, death within a very few hours.

The constitutional symptoms resemble to some extent those of septic fever, but they are much more severe. In most cases, those especially in which putrefaction is present, the wound is acutely inflamed; but I have known it, after an amputation through the knee-joint, progress, to all appearance, as well as could be wished, while the patient's temperature was gradually rising higher and higher, and the pulse becoming weaker and more feeble. The only local sign to attract attention was the presence of a thin serous discharge in enormous quantities. Much more frequently, however, putrefaction is present, and various forms of infective germs as well.

The pathological appearances present no distinctive feature of any kind. The blood either does not coagulate at all, or else forms a loose, soft, black clot, which readily breaks down again. The lining of the vessels and the endocardium are often stained, and sometimes marked by actual ecchymoses, which also occur on the serous surface of the viscera, and at times in their interior. The spleen is enlarged and softened; the liver and the lungs are congested; the structure of the viscera, on section, is confused and blurred, especially in the case of the kidneys; and the mucous membrane of the alimentary canal is frequently in a condition of acute inflammation, especially if the poisonous substance has been swallowed. When it is slowly absorbed from the surface of a wound, intestinal lesions are not usually present in man, though they are not uncommon in the case of animals. Decomposition after death, as in many other forms of septic diseases, is unusually rapid.

At the commencement there is usually a rigor or an attack of vomiting; the temperature sometimes rises rapidly, without any apparent reason, to 104° or 105° F.; sometimes, on the other hand, especially in the more severe cases, it rises a little at the first, and then falls again, even becoming sub-normal. The pulse is quick and feeble; the respiration hurried and shallow. The extremities are cold, while the trunk perhaps is burning hot; the tongue is dry and brown, and the lips and teeth covered with sordes. Diarrhœa, with blood-stained stools, is usually present in artificially-produced sapræmia, but is not frequent in man. As the temperature rises the patient becomes delirious; the prostration is extreme; the pulse is almost imperceptible; the forehead becomes covered with perspiration; the face grows more and more dusky; and at length, if the dose is sufficient, or if it is repeated, the patient sinks into a state of collapse, and the heart fails completely.

Treatment.—The local treatment, as in the case of septic fever, consists simply in thorough drainage, combined with the use of antiseptics. If the wound is on one of the extremities, nothing is more successful than a corrosive sublimate bath (1 part in 5,000); if this is impracticable, it should be thoroughly irrigated, great care being taken not to injure the surface. The object is to prevent further fermentation and absorption: if this can be accomplished, and the patient's kidneys are sound, so that the poison is eliminated, the prognosis is good, in uncomplicated cases. Unhappily, sapræmia is usually merely an addition to other even more serious affections.

It has been suggested that where any definite nervous symptoms are present, which it is known can be counteracted by the action of other alkaloids—dilatation of the pupil, for example—an attempt should be made in this direction; but cases in which this would be practicable must be very rare. After the acute symptoms have subsided, the anæmia and exhaustion left must be combated by iron, tonics, and nutritious diet.

Affections similar to septic fever and sapræmia are stated to have been caused by the injection into the blood of pepsin, trypsin, and other unorganised ferments.

CHAPTER III

DISEASES DUE TO INFECTIVE ORGANISMS

PATHOGENIC organisms are divided into two distinct classes, specific and non-specific. The former are always followed by the same disorder, under whatever circumstances they occur, whether they cause local and constitutional symptoms (anthrax, syphilis, &c.), or constitutional ones only (hydrophobia and tetanus); the latter, the non-specific ones, according to the modes of infection and the condition of the tissues, give rise to a variety of diseases: suppuration with its consequences, hectic and albuminoid degeneration; ulceration; gangrene; phagedæna; pyæmia, and many others.

1. NON-SPECIFIC

SUPPURATION

It is still open to question whether suppuration can occur from merely mechanical or chemical irritants, however persistently they act. As a matter of fact, as Ogston was the first to show, certain forms of organisms—staphylococci or streptococci in the vast majority of cases—are invariably present in acute abscesses, whatever share they take in their causation.

They enter either through a wound or through the mucous membranes, and travel by means of the lymphatics or blood-vessels. Some (staphylococci for the most part) lead to circumscribed abscesses; others (streptococci) spread by the lymphatics and are followed by diffuse suppuration. If the tissues are healthy they can do nothing—either they are killed or discharged in the urine. (It has been suggested that some are got rid of by the medium of the parotid, thus offering an explanation of the extreme frequency of what has been called parotid bubo, after operations and in the course of pyæmia; but it is at least equally possible that the organisms enter the gland through the duct.) If, however, they are arrested in a part the nutrition of which is impaired by injury of any kind—mechanical, chemical, or physical—particularly if there is any extravasated blood; or if, as in pyæmia, they are present in such numbers that whole districts of capillaries are simultaneously plugged, further changes take place in the tissue round and suppuration begins.

The effect is most characteristic in cases of simple inflammation. The blood in the centre of the affected area has ceased to move; in the rest of the vessels it is circulating very slowly; the plasma round the injured cells has coagulated, and all around the tissues near are in a state of immense activity; the vessels are dilated, the volume of plasma is increased, the number of free leucocytes is greater than ever, and every effort is being made by the developing granulation-tissue to absorb and replace the damaged structures. Suddenly a mass of staphylococci is brought to the part, either through a wound or the blood-stream. In the stagnant plasma and among the injured tissues they find a most favourable soil; the structures among which they lie at once begin to lose their distinctness of outline, the fibres swell up, become homogeneous and almost translucent; the leucocytes perish, and a ring of what is called coagulation-necrosis forms round the mass of germs, and spreads wider and wider. Probably its formation is due to the ptomaines they secrete. After a time the centre becomes liquid, and then a minute abscess is formed, lying in the middle of the inflamed tissues. Many of these small foci are usually situated close together, and, as they extend and widen, the intervening barriers soon break down.

Meanwhile, the tissues farther away from the irritant strive to protect themselves by throwing out a wall of lymph. At first, while the infection is still active, this melts away as rapidly as it is produced, the leucocytes perish and drop off as pus, and the *débris* of the tissues and the plasma (which is prevented from coagulating by the ptomaines) add to the amount. By degrees, however, the activity of the germs decreases, the wall of living leucocytes grows thicker, new vessels are developed from the dilated ones around, and at length a pyogenic membrane is formed and the spread of the suppuration is checked. It rarely happens, however, that it is stayed altogether. Owing to the extreme hyperæmia in all the parts near, the tension of the fluid in the interior is unusually high, and, aided by this, the action of the germs remains sufficiently powerful to continue the destruction in the direction of least resistance. Sometimes, owing to the presence of dense sheets of fascia, the pus spreads laterally for immense distances among the tissues; but sooner or later its course turns towards the surface; the skin or mucous membrane, as the case may be, gives way, and the abscess breaks and discharges its contents.

When the nutrition of the tissues is impaired by intemperance or prolonged residence in foul air; in pyæmia; and during convalescence from exhausting illnesses, suppuration sometimes occurs without local injury. The capillaries are plugged with micro-organisms at some small spot, and the walls of the vessels themselves are the first to perish and melt away. In such cases as these, or when the streptococcus pyogenes gains early access to the lymphatic spaces and spreads through them before the tissues can resist, a pyogenic membrane is never formed; the suppuration *is diffuse*; the strength of the tissues is so enfeebled that they disappear before the invading germs, unable to protect themselves by a barrier of any kind.

ABSCESS, OR CIRCUMSCRIBED SUPPURATION

Abscesses are acute or chronic according to the intensity of the symptoms by which they are attended, and the rapidity with which they spread. The latter are probably due to the same causes as the former, acting under less favourable conditions. Those, however, that result from the softening and liquefaction of masses of caseous material must be distinguished; they are always associated with the presence of specific germs, and for a long time, at least so long as they are chronic, do not contain true pus. It must be admitted that it is not always easy to draw a definite line between them.

Pus from an acute abscess in an otherwise healthy person, is a thick, creamy, opaque, yellowish-white, or greenish fluid, with an alkaline reaction and a specific gravity of 1030 to 1035. Its colour is due to the presence of small quantities of altered hæmoglobin; when it is red and mixed with blood it is known as *sanious*; if it is thin and watery it is called *ichorous*, and *curdy* when mixed with flakes of caseous material. Sometimes, when it comes from a mucous membrane, it is known as muco-pus; it may be *infective* from the presence of micro-organisms, and sometimes *specific* when it conveys the germs that give rise to definite diseases. In the neighbourhood of the alimentary canal it not unfrequently has a peculiarly offensive odour, although there is no direct communication, and the same thing is often noticed in connection with dead bone. In a few rare instances its colour is blue, owing, in all probability, to the accidental presence of a special organism (*micrococcus cyaneus*).

It consists of pus-corpuscles mixed with germs, floating in a highly albuminous fluid. The corpuscles themselves are, some of them, identical with leucocytes, and these are alive, capable of amœboid movements, but the vast majority are dead. They are round, slightly irregular on the surface, about $\frac{1}{2500}$ of an inch in diameter, and granular. The nucleus is generally bifid or trifid, and sometimes actually divided into two or three. The granules are, many of them, soluble in acetic acid, so that when this is added the outline of the nucleus becomes more distinct; but, after the pus has been some time in existence they chiefly consist of fat. In very old collections, fatty degeneration is complete, the corpuscles are entirely broken up, and nothing is left but a thick, putty-like, caseous material mixed with cholesterin crystals. The germs, for the most part, are streptococci or staphylococci. The fluid, unlike plasma, has no power of coagulating; it contains a large quantity of albumin and chloride of sodium, with small amounts of leucin, tyrosin, and other substances. Lime-salts and phosphates are present to a considerable extent, chiefly in the corpuscles.

When suppuration is very acute, shreds and sloughs composed of the denser tissues, such as fasciæ and tendons, are usually found floating in the pus; their vitality naturally is low, and the inflammation round them has killed them *en masse*—in other words, they are examples of necrosis and inflammatory gangrene on a small scale. Had they been of looser texture and more vascular they would have melted away, digested by the peptonising action of the cocci, and helped to form the albuminous fluid.

Symptoms. *Local.*—These at first are the same as those of inflammation, well-marked in the acute form, very indistinct in the chronic ones. Then, as fluid begins to make its appearance, the character of the *swelling* changes. At the commencement, if it is near the skin, it is bright red and firm to the touch; the surface is shining and pits on pressure (*inflammatory œdema*) and the depression so formed is well-defined and is slow in filling up again. By degrees, as the foci run together and the pus begins to collect, the centre becomes softer and more dusky; the abscess is pointing; then the skin near the middle, where it is most undermined, bulges out a little; the cuticle peels off; suddenly a small round opening makes its appearance, and the pus is discharged. In many cases, shortly before this happens a soft circular spot with sharply defined edges is felt on gently passing the finger over the surface, marking infallibly the part through which the pus will make its way.

When the abscess is of any size, the existence of fluid is detected by what is termed *fluctuation*—the wave felt by the fingers of one hand when pressure is made with the other upon a distant part. With large collections of fluid this can be made out at once, the amount of the displacement is so great; but with small ones, especially when they are deep-seated or tied down by unyielding sheets of fascia, it is often a matter of extreme difficulty.

At the same time it is impossible to overrate its importance. The further apart the fingers of the two hands can be placed the better. The pulps, not the tips, should rest upon the skin; two should be used if possible, but in many instances there is only room for one of each hand; those of the one should maintain a slight but perfectly uniform pressure upon the skin, those of the other should be gently but firmly pushed down at short regular intervals, and before a definite opinion is formed the action should be reversed. Of course fluctuation, even when the diagnosis is correct, can only be taken as a proof of the presence of fluid; it says nothing as to its nature, which may or may not be inflammatory.

In testing a part of the body in this way there are many sources of fallacy. An excellent imitation of fluctuation is obtained over a healthy muscle if the hands are placed side by side upon it, so that the wave is transverse. Soft, solid growths are so perfectly elastic that the same sensation is produced over them, and, though the distinction is of less importance as suppuration is almost sure to follow, areolar tissue infiltrated with inflammatory œdema often fluctuates distinctly; fluid is actually present, but instead of being confined in one central cavity, it is spread about in the loosely woven and softened network of fibres. In deep-seated abscesses, especially those which are tied down beneath dense sheets of fascia, as in acute periostitis, the œdematous swelling in the looser and more superficial tissue is so great that this false sense of fluctuation is all that can be felt. As, however, in itself it is almost diagnostic of the condition beneath, this is of less importance.

In addition to this the character of the pain changes as suppuration sets in. *Throbbing* is met with under other conditions, but it is seldom or never absent when pus is forming rapidly, especially if it is tightly bound down, and *tenderness* too often becomes much more distinct and localised.

Constitutional.—The fever that attends the formation and discharge of pus is in many respects highly characteristic.

At the commencement this is very often *a rigor* or shivering fit. This begins with a strange sense of chilliness, or actual cold, which may last only a few minutes, or may continue half an hour. At the same time there is a feeling of extreme prostration. The skin is pale, livid, and rough; the face is pinched; the eyes are sombre and surrounded by dusky rings; the respiration is hurried and shallow; and the pulse small, frequent, and feeble. Even at this time the temperature is higher than normal; the rise begins before the shivering, continues all through it (so that while the teeth are chattering, the skin is scorching), and through the period of dry burning heat afterwards, until sometimes it reaches 106° F. As soon as it ceases, profuse perspiration sets in, the temperature begins to fall; the face becomes flushed; the involuntary muscular fibre in the skin relaxes; the natural texture returns; and there is a sensation of profound relief, although the weakness and exhaustion afterwards are often extreme. Not unfrequently a herpetic eruption makes its appearance round the lips the day after a rigor, and in some cases spreads over the lower part of the face.

Typical rigors are by no means confined to the onset of suppuration. They occur at the commencement of many of the specific fevers, and in pneumonia and pyæmia. The first passage of an instrument down the urethra may cause one; or the first micturition after an operation. Those who suffer from ague are particularly susceptible to the urethral form, but nothing of the kind has been proved in reference to others. In children vomiting and convulsions occur instead, and in acute catarrhal inflammation, and sometimes in other forms, there is a succession of slight chills, lasting for many hours, instead of one definite one. The ultimate cause is unknown. No doubt, from the symptoms, they are due to the action of the nervous system, the medulla oblongata and the higher centres that control the production of heat in particular, but it is not known what the stimulus is nor how it acts. The suppurative rigor and that which heralds acute specific fevers may be caused by the absorption of some poison into the blood; and Harrison believes that this is true of urethral ones as well, the ptomaines present in the urine being absorbed through abrasions of the mucous membrane after micturition; but it is more probable that these are due to reflex irritation, whatever may be the cause of the others.

The subsequent course of the fever in acute suppuration depends upon the amount of absorption. In deep-seated inflammation the temperature frequently continues to rise until the wall of granulation-tissue is established; then it usually drops slightly of a morning (rarely a degree), rising again to its former level of an evening. As soon as the abscess is opened and tension relieved, absorption ceases altogether, the temperature falls to the normal, and if the drainage is what it ought to be, and decomposition does not occur, it does not rise again.

Suppurative fever must be distinguished from septic fever, although the two often occur together.

If the suppurative variety occurs alone, it pursues the course already described, the severity depending upon the tension. Sometimes, therefore, as in thecal abscess or whitlow, although the amount of pus is very small, the constitutional symptoms are exceedingly severe.

If the two are present together they cause hectic, the temperature continues to rise of an evening (although it may be normal of a morning), and the strength of the patient fails until, if the cause is not removed, death ensues from exhaustion.

If septic fever occurs, suppuration is sure to follow, unless the case proves fatal too soon. In a recent wound—a compound fracture, for example—in which the planes of cellular tissue up and down the limb are filled with extravasated blood, traumatic fever sets in first, with or without shock. Then, if decomposition takes place, septic fever follows, the limb becomes red and swollen, the temperature rises, delirium sets in, and the patient may die from acute blood-poisoning before there is time for suppuration. If he escapes this, the pyogenic organisms gain access to the part, the tissues, injured already by the action of the septic poison, melt away as pus, and in five or six days the fever begins to assume the suppurative type. After a time, unless the result is fatal in the meanwhile from exhaustion and hectic, the structural elements around regain their strength, a barrier of granulation-tissue is thrown out, the temperature falls of a morning, although it still continues to rise in the evening; and by degrees, if no further injury is inflicted, the suppurating area contracts, the absorption of the products of decomposing pus ceases, and the fever subsides.

Varieties of Abscess

Acute or Phlegmonous Abscess.—This is usually taken as the type of an abscess. All the symptoms are present, constitutional as well as local, and they are severe in proportion to its size and the degree of tension. Throbbing pain, heat, swelling, redness, and fever are well marked; inflammatory œdema is always present over it, and fluctuation makes its appearance at an early period, varying, of course, according to the depth. If it is not opened it makes its way in the direction of least resistance, undermines the skin, and bursts; the cavity contracts at once, and unless some cause, such as a foreign body or a piece of dead bone, keeps up the irritation, the granulations fall together as it collapses, and repair is completed in a very short time by their organisation.

Metastatic abscesses are a variety of the acute form occurring in connection with pyæmia. They are sometimes described separately because of their distinctly embolic origin: but if the view that suppuration is due to the action of cocci, conveyed to a distant part of the body, sometimes at least, by the blood-stream, is correct, the distinction does not appear a material one.

Caseous abscesses are due to the breaking down of old tubercular, syphilitic, or, in rare instances, epitheliomatous deposits. They are most common in connection with tubercular disease of the bone, especially of the spinal column; but they often originate in the lymphatic glands or the subcutaneous tissues—in any place, in short, in which a caseous deposit is found. Cocci are never present so long as they are chronic; and the material they are filled with, although it resembles pus in external appearance, contains very few pus-corpuscles, and consists chiefly of broken-down fatty *débris* mixed with fluid. Specific bacilli may be found occasionally in the tubercular variety, but much more frequently prolonged search has failed. From the fact, however, that pus of this description, if inoculated under suitable conditions, almost invariably causes local or general tuberculosis, it is believed that the spores, at least, must be present, although it may not be possible to demonstrate them under the microscope. Abscesses of this description not unfrequently attain an enormous size without their existence being known. There is no pain in connection with them, nor any fever so long as they are chronic. They are too deep-seated in most cases to cause any redness of the skin or swelling; and it is not until they have lasted perhaps for months, and have destroyed the tissues round them for immense distances, that they at length approach the surface. Even then the soft parts over them show no sign of active inflammation. The skin either remains entirely unchanged, or very slowly becomes thinned, reddened, and softened, until at length it gives way. The walls of these abscesses, especially the older parts, are usually dense and hard, containing few vessels, and lined with a layer of cheesy *débris*; they do not collapse and cohere like those of acute ones, and this is one of the chief difficulties in treating them. The cavity, too, is often of the most irregular shape, with large offshoots running in all directions and crossed by bands and septa, many of which contain important vessels and nerves. In short, they are so altogether different from acute abscesses in their contents, character, and behaviour, that, except as a matter of convenience, they should not be classed with them. Even their termination is different. It very rarely happens that acute abscesses dry up or disappear. With these this ending is not at all uncommon. The fluid is gradually absorbed: the caseous material becomes more and more inspissated; and at length it undergoes calcification, nothing being left but a dense, chalk-like substance, lying in the centre of a capsule of fibrous tissue.

Unfortunately this termination cannot be relied upon. If left, caseous abscesses for the most part only grow larger and larger, destroying more and more, and becoming more complicated in shape, until either they break, or, from some accidental cause, the cocci of true suppuration gain access to them, and they become acute.

Chronic abscesses that are not of tubercular origin are much more rare, but occasionally they are found—in the breast, for example—or locked in the interior of a bone. The irritant that has caused them has been of very slight intensity, and the tissue in which they lie has surrounded them with a capsule so hard and dense that escape is out of the question. Sometimes these, especially when they occur in bone, are the source of severe pain.

Residual abscesses are akin to these, although many of them probably are tubercular. Typical ones are met with in old cases of joint-excision. Years after the operation an abscess, often of very large size, forms rather rapidly in the cicatrix. It may be due to an old tubercular focus which has been left behind suddenly waking up again after some slight injury; or to the fact that extensive masses of cicatricial tissue are very poorly nourished, and very prone to break down from trivial causes. The prognosis is always good.

Cold or congestive abscesses are usually met with in connection with the lymphatic glands, generally in the axilla or the groin. The patient has been out of health for some time, and has received some slight scratch or bruise. A few days afterwards, perhaps when the original injury is well and forgotten, a certain degree of stiffness is felt, and suddenly a huge swelling is discovered, very soft, fluctuating, and painless, with but little sign of fever or inflammation. The contents are usually thin and rather oily, and not unfrequently it takes a long time for the patient to recover.

Tympanitic abscesses, containing gas as well as pus, are occasionally met with in the neighbourhood of the alimentary canal, not necessarily in connection with the intestine, though this is very commonly the case.

Diffuse suppuration is only met with when the action of the poison is very intense, or the resistance of the tissues exceedingly feeble, and is usually associated with streptococci, as well as staphylococci. The symptoms of inflammation may be well-marked, but not unfrequently they are altogether concealed, the fever assuming a typhoid or adynamic type, and the nervous system being so overpowered that pain is scarcely felt.

Diagnosis.—If the part involved is superficial, and the signs of inflammation are distinct, there is little or no difficulty; when the converse of this is the case, it may be impossible. The occurrence of a rigor; the presence of throbbing pain, and of inflammatory œdema; a softer spot appearing in the middle of a mass of hardened tissue; and the sensation of fluctuation, are the most important diagnostic signs; but any of these may be absent, or even all of them; and it must always be remembered that fluctuation only indicates the presence of fluid, and of itself gives not the slightest clue as to its nature. In cases of doubt, and particularly where the diagnosis has to be made from cysts or soft solid growths (which may be attended by all the signs of inflammation—hectic, local heat, redness, swelling and pain), it is advisable to make use of an exploring-needle (grooved so that fluid can escape along it) or a long fine trocar and cannula. Very little harm can be done with either of these, if carefully used; the liver, for example, may be punctured in all directions, almost with impunity; and the result can be relied upon. Even in those cases in which a caseous mass prevents the exit of any fluid, evidence of its presence may generally be found at the end of the cannula when it is withdrawn.

Treatment.—1. *Acute Abscesses.*—Preventive measures may be tried first; but, as a rule, if there are fair grounds for suspecting suppuration, the sooner an incision is made the better. In cases in which pain is severe and tension high (as in whitlow, acute periostitis, and phlegmonous inflammation of the cellular tissue) it is certainly not advisable to wait. Free incision is the best prevention.

Incision is the only method of treatment. If the abscess is pointing, or if, short of this, there is one spot more tender than another, or at which the skin is more adherent or œdematous, the question of locality is settled. Where there is no indication of this kind, either the most dependent part is selected, or that which appears advisable for anatomical reasons. Superficial veins and nerves, for example, should be avoided; natural folds of the skin selected as far as possible; and, above all, especial attention paid to the depth, position, and direction of the more important structures, such as vessels and ducts. If an incision must be made in their neighbourhood, it should be parallel to them.

No plunge should be made in opening an abscess. The spot is selected, and the scalpel or abscess-knife introduced perpendicularly until either the sense of resistance ceases, or, when the blade is slightly rotated, the pus wells up round it. Sufficient length is obtained in cutting outwards. Deep abscesses, lying among important structures, are opened either by dissection or by Hilton's method. If, for example, there is suppuration beneath the deep cervical fascia, and the position of the vessels is uncertain, an incision half or three-quarters of an inch in length is made through the superficial structures, and a steel director pushed into the most prominent part of the swelling. As soon as it reaches the fluid, a little escapes along the groove. Then a pair of dressing-forceps, with the blades closed, is passed along the director, and the wall of the abscess, and the structures over it, torn as far as may be necessary by separating the handles.

An abscess should never be squeezed; it only makes the granulations bleed. If the sac is small and the tension high, the contents are soon forced out by the neighbouring structures; and if the incision is of proper size and in proper position the cavity is obliterated almost at once. All that is required is an absorbent dressing to take up the excess of fluid that is secreted at first, owing to the sudden removal of the tension from the vessels in the newly formed granulation-tissue.

When the abscess is deep-seated or complicated in shape, this is not enough. If it lies beneath a layer of fascia, or if the surrounding structures have been much displaced by its pressure, the deep wound, when the tension is relieved, does not correspond to the superficial one. The opening is valvular and the contents cannot escape freely. In this difficulty a drainage-tube must be used.

The best are simply lengths of red rubber tubing kept ready in a five per cent. carbolic solution. The size selected depends, to some extent, upon that of the abscess and the character of its contents, but, as a rule, the larger the better. Small ones soon become blocked and increase tenfold the danger they are intended to prevent. Nothing is more common than to see a gush of fluid when they are withdrawn. The walls must be flexible, but firm enough to maintain the patency of the interior, and openings must be made in them here and there. The deep end is passed by means of a probe or sinus-forceps quite to the farther limit of the sac: the superficial one is just flush with the skin, and is provided with a ligature to secure it if required. The wall of an old abscess is thick and rigid; the structures round have grown accustomed to its presence, and do not obliterate the cavity when the tension is relieved; and for this reason, unless the freest possible exit is given to the contents by means of a dependent opening and a large drainage-tube, some is sure to remain behind and decompose.

In large abscesses it is advisable to make two openings and pass a drainage-tube right through. After two or three days it may be withdrawn, and two, one at each opening, substituted for it. As the structures round recover themselves and become pressed together, the middle portion of the sac is obliterated, and when the granulation-tissue begins to contract, the tubes are gradually forced out.

Wood-wool, or moss, impregnated with corrosive sublimate is a most efficient dressing, but any other substance that is sufficiently absorbent and capable of preventing putrefaction may be used instead. The dressing should be thick and cover some distance round; the compression helps the abscess to contract, keeps the part at rest, and maintains an even temperature. The frequency with which it is changed depends upon the amount of discharge; in many cases a single dressing is sufficient. The temperature, if the abscess is drained thoroughly, falls at once to normal; if it rises above 99°, at any rate on more than one evening, it is almost certain that the exit is not free.

Metastatic, residual, and cold or lymphatic abscesses present no peculiarities. Chronic ones, locked in bone, naturally require special treatment. If suppuration is diffuse, free drainage is even more imperative than when it is circumscribed; it is just possible that relieving the tissues of the additional irritation of tension may turn the scale in their favour, and enable them to throw out a protecting barrier; but it must be remembered that in these cases there is, as a rule, progressive inflammation to deal with as well.

2. *Caseous Abscesses.*—The treatment of caseous or tubercular abscesses requires special mention. An acute abscess, unless there is some complication present, discharges itself of all its contents as soon as the tension is relieved, and organisation begins at once. In these, on the other hand, the reparative power of the tissues is very feeble, the walls are dense and rigid, so that they do not collapse, and the caseous *débris*, especially the more solid part, has a great propensity for clinging to the interior. In other words, even when they are small it is not easy to procure free and efficient drainage; when they are of large size, as in the case of many spinal abscesses, and divided into a series of successive chambers by septa springing from the walls, or provided with offshoots spreading in all directions, the difficulty becomes a very serious one.

Formerly it was the practice to leave abscesses of this kind severely alone as long as possible, more especially as, in a certain small proportion, the caseous material gradually dried up, and either became absorbed altogether or converted into a calcareous mass. Now, on the other hand, it is recognised than the earlier such an abscess is emptied the better the prospect of speedy recovery, and the less the risk of its proving ultimately a focus for tubercular dissemination.

Many of them occur under conditions that necessitate special treatment. Such, for example, are the caseous foci found in tubercular epididymitis and in so-called strumous disease of joints. Others—those, for instance, that are met with in lymphatic glands or in the cancellous tissue at the epiphysial ends of the long bones—may be very briefly dismissed; they should be opened as thoroughly as possible; the lining of granulation-tissue, covered with caseous material and infiltrated with tubercle, scraped out with a Volkmann's spoon, and iodoform dusted over the interior. The difficulty is in dealing with the large ones, which cannot be treated in this fashion.

Aspiration is harmless and sometimes succeeds. The instrument ordinarily used is a modification of Dieulafoy's, consisting of an exhausting-syringe or glass receiver, and a trocar and cannula so contrived that the former can be withdrawn and the latter brought into connection with the receiver without destroying the vacuum. Care must be taken that the instrument is absolutely clean (I prefer to have all cannulæ boiled in liquor potassæ in a test-tube just before using; no oil then is required); the opening should be valvular, and the trocar should reach well into the cavity before it is withdrawn and the connection established. No attempt is made to empty the abscess; as a matter of fact it cannot be done; a large amount of the caseous material clings obstinately to the wall, and if it is detached blocks the cannula; and great care should be taken not to make the granulations bleed, either by bringing the end of the instrument into contact with them or reducing the tension too rapidly. The vacuum should be maintained as the needle is withdrawn, for fear of its leaving some of the caseous *débris* in the wound. As the abscess is not emptied, the beneficial effect must be due to the relief of the tension; sometimes absorption and condensation follow; much more frequently the cavity slowly refills. If the aspirator is used more than two or three times, the openings fail to heal; a little thin serum escapes from them, the margins begin to ulcerate, and the contents slowly drain away.

Small abscesses are sometimes emptied in this way, or with a trocar and cannula, and then injected with an emulsion of iodoform in glycerine (one in ten) or a five per cent. solution of the same drug in ether. The former is especially recommended, as, owing to its high specific gravity, it sinks down through the caseous *débris* which collects upon the floor, and penetrates to the granulations; but there is some risk of iodoform-poisoning.

Large abscesses—those, for example, in connection with disease of the spine—must be opened and drained. Two incisions are always advisable—one at the most dependent part, the other as near the seat of disease as practicable. Sometimes, when there are large outlying pouches, a third is required. The interior should be explored with the finger, to ascertain, as far as possible, its extent, and whether the disease which has given rise to it is within reach of treatment, but it should not be scraped out, for fear of hæmorrhage and of damaging important structures running in the wall or across the cavity, or washed out with antiseptics. Then a very large drainage-tube should be inserted, or, if necessary, more than one, and absorbent dressings applied. If the drainage is thorough, the caseous material that clings to the wall is thrown off by the granulations with the serum that exudes from them; the amount of discharge is reduced to a few drachms of turbid fluid, and gradually, as the structures round collapse upon the cavity, all the outlying parts close up, leaving only one sinus, leading, by as straight a route as possible, down to the seat of disease.

When this is not feasible, Hamilton's method of irrigation with chloride of zinc (one part in 200) may be adopted. A rubber tube, with a single opening in the side, is passed across the abscess-cavity; one end is connected with an irrigating can, the other with a receiver, and the fluid (which is quite inert as a germicide) is allowed to flow through drop by drop, the rate being regulated by means of a stop-cock. After a week the openings begin to leak, and then the continuous irrigation can be dispensed with; the cavity throws off the inner lining in shreds, and gradually heals up. The object is to place the tissues under the most favourable conditions for getting rid of the noxious material that lines the cavity by themselves and for themselves.

When efficient drainage is impossible, so that there must be some residue of dead putrescible fluid in the cavity, or Hamilton's plan is unsuitable, Lister's method, or some modification of it, may be used. It aims at preventing the access of the germs of putrefaction, and if it is carried out at all, must be done thoroughly. These micro-organisms (unlike those of suppuration, which can be conveyed from one part of the body to another, and can enter through the alimentary or respiratory tract, and cause the formation of pus wherever they meet with tissues too feeble to resist them) are unable to act on living tissues at all; they must have dead material at a certain temperature, and with a certain amount of fluid—conditions which are perfectly fulfilled in ill-drained abscesses.

The skin over and in the neighbourhood of the wound is thoroughly cleansed with an antiseptic (carbolic acid, 5 per cent., is the usual one) and, if necessary, shaved and purified from any fatty matter that may adhere to it, with ether or some strong alkali. The instruments, the hands of the operator, the sponges, and everything that can possibly come at all near the wound, are treated in the same way. The air is purified with a spray of carbolic acid (though apparently this is not regarded as of so much importance now, irrigation being substituted for it more or less), so that the wound, the hands of the operator and his assistant, the drainage-tubes—everything, in short—are wrapped in a carbolic cloud the whole time; if anything, even for a moment, emerges from it, it must be dipped at once in carbolic solution before it is brought near the wound. After the abscess is opened, and the immediate discharge from it has ceased, a drainage-tube is carried down to the bottom and secured in the ordinary manner, and then special dressings are applied.

The wound itself is covered with what is known as protective—oiled silk coated with copal varnish and brushed over with dextrin. This is dipped in carbolic lotion first. In the case of a recent wound it is just large enough to overlap the edges all round and protect the healing surface from the irritating effect of carbolic acid. Over this is laid a dressing of specially prepared gauze. As a rule it consists of tarlatan impregnated with a mixture of one part of carbolic acid, four of resin, and four of paraffin: but eucalyptus, salalembroth, and other substances are sometimes used instead. The dressing next to the protective is dipped in a solution of carbolic acid ($2\frac{1}{2}$ per cent.), because when dry the disinfectant is not given off readily, and a particle of dust that had escaped the spray might come into contact with the drainage-tube. Over this, covering the skin for a long distance round, is the superficial dressing; eight layers of gauze (dry, but prepared in the same way) with, beneath the outer layer, a piece of macintosh cloth, so that the discharge may diffuse itself over the whole without coming into contact with the air at any one spot. Elastic bandages are used round the edges, especially where, as in the groin, there is likely to be any movement; gauze bandages for the rest. If the surface is uneven, or if a large amount of discharge is expected, loose gauze rolled up lightly is placed, as much as may be necessary, between the superficial and the deep dressings.

The dressing is changed the day following the operation, using the same precautions, and taking great care not to lift it up towards the spray, but away from it, so that no unpurified air may enter beneath. Afterwards it is left until the discharge is apparent somewhere at the edge; but never for more than a week.

Hectic

Profuse and long-continued suppuration is accompanied by a peculiar form of fever known as 'hectic.' The temperature is perfectly regular, but remittent. In the morning it is normal, or only slightly raised; in the evening it is 102°, 103°, or even 104° F. As the rise begins, always at the same time, there is a sensation of heat and thirst, sometimes preceded by a chill; the face becomes flushed, especially the cheeks, on which there is often a bright red and strictly limited patch; headache comes on, with a feeling of extreme weakness and depression, and the patient is restless and uncomfortable, tossing about in bed, unable to sleep. Then towards morning the temperature drops; there is profuse perspiration, often soaking the bed-clothes; and the patient falls into a deep sleep, which may last till late in the day.

The pulse is always rapid, becoming softer, smaller, and more frequent as the case goes on. Emaciation is extreme; the eyes are sunken and bright, the pupils dilated, the skin anæmic, and the tongue very red, especially at the tip and edges. The urine deposits urates copiously, and diarrhœa is of common occurrence towards the end; the strength fails rapidly; the mind begins to wander; the power of taking food diminishes, and at length death ensues from sheer exhaustion.

The most typical examples of hectic are met with in cases of empyema or of large abscesses connected with the spine or hip that have been imperfectly drained; but it may follow suppuration in any part of the body. It does not occur before an abscess is opened, and there is no doubt that it is due to the absorption from the granulating surface of a substance produced by the fermentation (not necessarily putrefactive) of the discharge. The greater the amount of discharge and the larger the absorbing surface, the worse the fever.

The treatment depends upon the cause; if this can be removed, the fever ceases; if it cannot, the course may be delayed, but the end cannot be prevented.

The strength must be supported by nourishing diet, tonics, iron, quinine, and cod-liver oil. Stimulants, especially port wine, are of undoubted use. The diarrhœa must be kept in check by astringents and mineral acids. Opium should only be given as a last resource, to relieve pain. The night-sweats, which are very weakening, can be checked by belladonna; and the formation of aphthous ulcers in the mouth and on the tongue (which are very injurious from the pain they cause in mastication and deglutition) must be prevented by means of borax and chlorate of potash.

Typical hectic, with emaciation, flush, and profuse night-sweats, is met with in connection with many varieties of rapidly-growing malignant tumours. The cause is not known.

Albuminoid Degeneration

This is one of the consequences of prolonged suppuration often associated with hectic. It has, however, been known to occur independently of the formation of pus in syphilis and malaria. In surgery, at least, it is usually met with in connection with tuberculous disease of bones or joints, and as a consequence of empyema.

Morbid Anatomy.—The liver, spleen, kidneys, and the mucous membrane of the intestines are the parts usually involved. It begins in the media and intima of the small arteries and capillaries, and spreads from them to the connective-tissue elements and the unstriped muscular fibres. The epithelial lining atrophies. The substance of the cells is changed into a firm, homogeneous, waxy material, which appears translucent in thin sections, stains mahogany-brown with iodine, and red with methyl-violet. It is nitrogenous, resembles albumen in many respects, but resists digestion and putrefaction.

Symptoms.—The liver retains its shape more or less, but slowly and steadily increases in size until it may reach into the iliac fossa. It is firm, hard, and resistant; the edge can be felt with unusual distinctness; there is no pain or any apparent derangement of function. The spleen enlarges in the same way. The kidneys show the effect by the alteration in the urine; this increases in quantity, diminishes in density, and in the later stages contains a small amount of albumen and some hyaline casts. The mucous membrane of the intestine does not become involved until comparatively late, when naturally emaciation and diarrhœa soon become prominent features.

The aspect of the patient is characteristic. There is a peculiar waxy pallor of the face which is unmistakable, and is of itself sufficient to establish a diagnosis. In addition, the anæmic condition of the lips, the emaciation, and the protuberant abdomen, can usually be recognised at once.

Early removal of the cause has been followed by complete disappearance of all the symptoms, so that, some years after, no evidence of such a change could be detected. If this is attempted, however, it must be done before the disease is too far advanced.

Hæmorrhage into an Abscess

Capillary oozing is very common; the granulations are exceedingly vascular, and the sudden relief of tension causes some of the thin-walled vessels to give way; but it is very rarely serious. Usually it stops at once on exposure; if it does not, ice may be applied locally and the part well raised. In very bad cases it may be necessary to plug the cavity with iodoform gauze—but this is very likely to be followed by a considerable degree of fever.

Venous hæmorrhage rarely occurs, except from scarlatinal or diphtheritic sloughing in the neck. In this case the cavity should be thoroughly dried. the hæmorrhage being checked meantime by pressure; dusted well with iodoform, in the hope of staying the sloughing; and packed with iodoform wool or gauze; but, especially in the case of the internal jugular, the prognosis is almost hopeless. If iodoform fails or is not at hand, turpentine is probably the most efficient agent.

Arterial hæmorrhage may occur under the same conditions, from ulceration into the carotid, or in the groin from the extension of phagedænic bubo. The latter appears to have been more common in days gone by. Occasionally it is met with on the extremities, from the pressure of drainage-tubes or of sharp edges of bone. Fortunately the hæmorrhage is rarely instantaneous; in nearly every case there is a warning. The treatment varies according to the circumstances. In the neck, if it is in the carotid or one of the branches near the main trunk, this must be ligatured at once. In the thigh, if only a few drops escape, cold and pressure may be applied; but a tourniquet, unscrewed, must be placed upon the limb higher up, and a nurse or dresser told off to watch; and if there is the least recurrence, no further delay is admissible. In the leg, amputation is usually required.

The complication is a rare one. I have on several occasions seen arteries lying, exposed and beating, on the floor of ulcers, without hæmorrhage ever occurring. As the inflammation extends into the coats, the endothelium becomes affected and a thrombus forms. Suppurating aneurysms are by no means always followed by hæmorrhage. If, however, there is a foreign body cutting into the wall of the vessel, or if the ulceration is phagedænic, or even septic and diffuse, as in those whose health is broken down from intemperance and exposure, the destruction may advance too quickly for repair, and then hæmorrhage follows.

Sinus and Fistula

A sinus or fistula is the suppurating track left by the imperfect healing of an abscess. The distinction between the two is not accurately kept. Strictly, the former has only one opening, and that upon the skin; but so long as there is no communication with an internal cavity, or with any of the hollow viscera (such as the bladder), the number is not material. A tubercular abscess, for example, may have two or more connected by channels running in the subcutaneous tissue. In the same way a fistula should have two, of which one communicates either with the viscera or with a cavity of some kind; the other may or may not be on the exterior; in recto-vesical fistula, for example, both openings are internal; in the biliary variety, only one; but blind fistulæ (which are identical with simple sinuses) are occasionally spoken of in connection with the anus, on account of the close resemblance they bear to complete ones.

Causes.—Non-closure of an abscess is due to the persistence of some irritant: tension, as when the contents cannot escape freely; want of rest, owing to the continued action of muscles—the sphincter ani, for example; the presence of dead bone, tubercular deposit, or foreign bodies introduced from without; and the existence of an obstruction to one of the natural ducts, as in stricture, are the most common. Occasionally fistulæ are caused by actual loss of tissue (especially vaginal ones), or by the presence of malignant growths.

As a rule a sinus or fistula forms a narrow, more or less tortuous canal, lined with a kind of granulation-tissue which secretes a thin watery pus. Exceptionally, when it is very short, as between the rectum and the bladder, it is covered with epithelium. The external orifice varies according to the cause; when it is due to dead bone there is usually a protuberant button of granulations, in the centre of which is a very small opening. Tuberculous sinuses, on the other hand, are surrounded by ragged, blue, and undermined edges. In the case of old fistulæ, the opening is not unfrequently depressed and sunken, because of the contraction of the granulation-tissue underneath. The internal orifice is generally well-defined, although that, too, may be concealed beneath a flap of mucous membrane.

When of recent formation the structures that form the wall are soft and yielding; but in old cases, particularly those in which the fistula gives exit to one of the secretions, they become hard, dense, and cartilaginous, so that, even when the cause is removed, healing is almost impossible without something further being done.

Treatment.—In recent cases it is sufficient to remove the cause. Dead bone must be withdrawn or scraped away; a stricture must be dilated; if there is not free exit for the secretion, the orifice must be enlarged with a drainage-tube or tent, or by an incision; and if, as in the case of sinuses in the groin, the continual movement of the part prevents healing, pressure may be applied. Even those left by suppurating buboes can be induced to close by the proper application of a truss. In many cases, of course, the removal of the cause entails a serious operation. Fistula in ano, for example, is originally due to an abscess; but its persistence is the result of the sphincter, and this must be divided before the wound can close.

In others in which, without any definite reason being found, the wound refuses to heal, an attempt may be made to stimulate the part, or even, in old cases, to excite acute suppuration. In those cases in which the walls are very thick and dense, this is the only way. Injection of tincture of iodine may be tried first; or the introduction of a probe coated with nitrate of silver. If this fails, the granulations may be thoroughly scraped out with a sharp spoon or destroyed with the cautery. Finally, sometimes the only measure of any use is to lay the whole open from one end to the other, partly to place it at rest, partly to destroy the hardened, thickened tissues, by causing acute suppuration. Where bleeding is feared, this is sometimes done with an elastic ligature tied as tightly as possible.

Large fistulous openings between hollow viscera, or between one of these and the exterior, very often require extensive and repeated plastic operations.

ULCERATION

Ulceration is the molecular disintegration and removal of the superficial structures of the body, by the action of certain irritants, just as suppuration is of the deeper ones. An ulcer is the sore formed in the process, and in the same way corresponds to an abscess.

A burn—the actual cautery, for example, applied to the skin—does not leave an ulcer, provided no other irritant is allowed to appear. A portion of the skin is killed; the surrounding tissues at once begin to act with increased vigour, because there is more work, more repair to be done; lymph pours out; new vessels are formed; vascular granulation-tissue is produced in sufficient amount; and the dead part is replaced, more or less perfectly, without a trace of suppuration, in exactly the same manner as if it were an extravasation of blood caused by a bruise deep in the substance of the body.

If, however, any further injury is inflicted on the part—if the burn is exposed to the air, so that the dead tissue decomposes; or if the surrounding living parts are constantly rubbed by the clothes; or if they are injured in any other way—inflammation sets in; the pyogenic organisms seize their opportunity at once; molecular disintegration begins on the surface of the body, and an ulcer is produced.

As soon as the irritant ceases and the tissues gain the upper hand, vascular granulation-tissue is formed, as round an abscess; destruction comes to an end; organisation sets in, and the wound begins to heal. Sometimes this is called a healing ulcer; but the term is an unhappy one, as the ulceration has ceased.

Causes.—The causes of ulceration are the same as those of suppuration, predisposing and exciting. The former include everything, hereditary or acquired, local or constitutional, that can in any way impair the vitality of the tissues; and these are of especial importance when the process is chronic; the latter are the same forms of micrococci that occur in acute abscesses. They generally gain access to the tissues from the surface (sometimes, as in pyæmia, through the blood); and the cells and fibres melt away before them because they are too weak to resist. There is the same contest between the irritant and the power of repair; sometimes one gains the upper hand, and sometimes the other, and, as the case may be, the ulcer spreads or heals. Not unfrequently, especially on the leg, there is scarcely any progress one way or the other for years. The irritant has very little power, but the tissues are so badly nourished that they cannot throw it off; and each winter, especially as age advances, sees the ulcer slowly getting larger.

There is the same question as in suppuration, whether long-continued mechanical or chemical irritation can cause ulceration of itself without the peptonising action of the micrococci; but the discussion is even more barren, as they are invariably present.

Varieties.—*Simple ulcers* may be compared to acute abscesses, with this distinction, that septic germs, causing decomposition of the discharge, are (unless steps are taken to prevent it) always present with the pyogenic ones, weakening the tissues for them, and preparing the way for their action.

Specific ulcers resemble, but less closely, caseous abscesses. These are due to the softening and disintegration of tubercular, syphilitic, and occasionally epitheliomatous masses in the interior of the body; but, except in certain rare instances, they do not contain true pus until they are opened. The corresponding forms of ulcers are never the result of unmixed disintegration in this way. In addition to the caseation and liquefaction, septic decomposition is always present, and pus as well, from the presence of pyogenic micrococci.

It is probable that the phagedænic and gangrenous forms which are usually separated from the rest, are merely the result of the ordinary germs, acting with greater intensity than usual, sometimes for anatomical reasons; more frequently because the vitality of the tissue is greatly impaired; or because there is some other poison (that of syphilis, for example) at work as well. They may be compared to diffuse suppuration; the process of destruction is too rapid for the tissues to throw out a barrier of granulations, or the poison is so intense that the barrier already thrown out disappears.

As soon as the tissues are able to get the better of the irritant, the leucocytes cease to melt away as pus; the peptonising action of the micrococci becomes feebler; coagulable lymph is formed; and new blood-vessels are thrown out. In other words, a layer of vascular granulation-tissue is developed upon the floor of the ulcer, exactly like a pyogenic membrane round an abscess; and repair begins at once, as in any other healing wound, by organisation and contraction beneath, and organisation and the formation of an epithelial layer above.

GANGRENE

By *gangrene* or *mortification* is understood the death of a part of the body. A certain size is implied, in distinction from ulceration, in which the destruction is molecular and the tissues melt away imperceptibly; but small patches of gangrene are often present on the floor, or round the edges, of spreading ulcers, and the line between them is ill-defined. The term *sloughing* is used for the soft tissues; *necrosis* for the hard ones—bone and cartilage; and, in the latter case, the dead portion is known as a *sequestrum.*

Gangrene is *dry* or *moist* according to the changes the part undergoes. In the dry form the colour at first is pale, or dead white with a bluish mottling here and there; the skin is shrivelled, and as it were shrunken on to the structures beneath; at first, it has a peculiar semi-translucent look; but very soon it loses this, becomes opaque and dark, and then grows more and more black until at length the part becomes hard, dried, and mummified. Putrefaction cannot occur, because there is no fluid. In the moist form, on the other hand, decomposition is always present. The part is engorged with blood; the hæmoglobin soaks through and stains the skin, so that it becomes dark and livid; bullæ form on the surface, filled with reddish fluid of a very offensive description; the epidermis is detached; ashy-grey or green patches make their appearance; the part becomes swollen, and crackles under the finger from the formation of putrid gases; and the smell is most offensive.

Which of the two forms occurs depends upon the amount of fluid present. Dry gangrene, therefore, is chiefly met with in old people, with thin, spare limbs, in whom the arteries supplying the part slowly become blocked with thrombi. Even in them, however, a certain amount of decomposition usually takes place as the line of separation is formed, or when the gangrene involves the calf. In the former case, the necessary amount of fluid is supplied by the liquefaction of the plasma under the influence of the pyogenic organisms; in the latter, it comes from the tissue itself.

Causes.—The causes of gangrene are the same as those of inflammation, physical and mechanical irritants, and infective organisms. The chief difference is, that they kill the tissues outright, either directly or by cutting off the blood-supply, instead of merely impairing their vitality.

1. *General.*—These are, for the most part, predisposing only, but sometimes they are so powerful that, as in Raynaud's disease, it is scarcely possible to find a local one. They include anything that can in any way impair the general health or interfere with the quantity or the quality of the circulating blood. Cardiac disease of all kinds, valvular and degenerative; loss of blood; exhausting illnesses; prolonged fevers; Bright's disease; diabetes; exposure; starvation and intemperance, are some of the most common. The

prolonged use of ergot is said to lead to gangrene, but probably only when it is assisted by other causes.

Most of these act upon the tissues directly as well as through the circulation. Whether loss of nerve-power has much influence, except in so far as it impairs nutrition from disuse, is uncertain. There is more evidence in favour of nerve-irritation. That inflammation can be induced in this way is generally admitted; and there are cases on record in which the process has been so severe as to lead to gangrene of the most acute type—sloughing bed-sores for example—within twenty-four hours after an injury. Whether this is due to trophic nerves, or to spasmodic vaso-motor contraction, brought about by reflex irritation, is not known. The existence of the former is not proved; while in favour of the latter is a remarkable case recorded by Hilton, in which the pressure of an exostosis upon the ulnar nerve caused gangrene of the little and adjacent side of the ring-finger, the stimulus conveyed by the sensory fibres to the nerve-centre being reflected down the vaso-motor ones to the vessels, and cutting off the blood-supply.

2. *Local.*—Any kind of irritant can cause gangrene, the degree of severity required being in inverse ratio to the activity of nutrition; a scratch or bruise is sufficient when the vitality of the part is low.

(*A*) *Physical or Mechanical Irritants*

Some of these act upon the tissues themselves; others kill them by cutting off the blood-supply. Heat and chemical agents are examples of the former, arterial obstruction of the latter.

Obstruction of an artery may be due to rupture, ligature, pressure, thrombosis, embolism, or inflammation. As a rule, the collateral trunks enlarge sufficiently to make up for it; but if the vessel that has given way is a large one, so that there is an enormous extravasation under high pressure; or if the walls of the other vessels are rigid and atheromatous, so that they cannot dilate, the blood-supply is cut off and that part dies. Venous obstruction, owing to the freedom of anastomosis, rarely leads to this; but in strangulation by ligature, or when a piece of intestine is caught in a narrow canal, the veins are compressed first, and the congestion so caused gradually blocks the arteries.

(*B*) *Organised Irritants*

These are the same micro-organisms as in inflammation, only they are acting now with greater intensity. In the one case they lower the vitality of the tissues, in the other they destroy it. They differ from physical and mechanical irritants in the fact that their action is continuous; they spread wider and wider, invading the tissues farther and farther, until either their energy is spent or they meet with some part sufficiently well-nourished to resist.

Of these some are certainly specific (anthrax, malignant pustule, glanders, and possibly a few more). Others which, like these, invade living structures, do not give rise to specific diseases, but merely to inflammation of great severity. They impair the vitality of the tissues to such an extent that they slough. This is the case with spreading traumatic gangrene and hospital gangrene; no specific germ has been proved to exist in them; they are merely the result of the ordinary organisms of suppuration acting under peculiarly favourable conditions. Whether noma, cancrum oris, and phagedæna should be included is still a matter for question. Carbuncles and boils are undoubtedly due to ordinary micrococci.

This form of gangrene is always moist; putrefaction is present as well wherever the slough is exposed to the air; and the products bathing the surface of the sore, lowering the strength of the patient as well as the vitality of the tissues, materially assist the progress of the original cause.

Subsequent Course

As soon as a part of the body has been killed, whether by mechanical, physical, or organised irritants, an attempt is made to get rid of it. The success which attends this depends upon three conditions: the nutrition of the tissues, the persistence of the original irritant, and the presence or not of any other in addition.

1. *Where the tissues are healthy, where the injury is not repeated,* and where no other irritant is allowed to intervene, the dead portion is either absorbed or thrown off, according to its position.

If it is in the interior of the body it simply undergoes degeneration and is quietly removed. A portion of tissue that is dead acts as a very slight irritant on the structures round. The pedicle of an ovarian tumour that has been ligatured and returned into the abdominal cavity is an instance; the neighbouring tissues become more vascular, leucocytes and plasma pour out in greater amount, the strangulated part gradually becomes invaded by them, new vessels are formed and extend farther and farther into its substance, and at length it completely disappears. In the same way a bony sequestrum of small size, and even dead substances of an entirely foreign nature, such as ivory pegs, can be removed.

If it is in the skin, under the same conditions, the same changes occur round the buried part, but the exterior dries up and becomes hard and dense. Absorption, accordingly, is impossible, except to a very slight extent; the lymph that is thrown out by the living tissues becomes organised; the deep part is converted into fibrous tissue; the superficial, where it is in contact with dead material, is covered over with epidermis, which grows in from the margin round, and at length the dried-up mass drops off by itself, leaving a perfectly healed surface beneath. A burn, for example, covered up at once may remain dry, and form a scab under which repair is completed without the least further loss of tissue or suppuration. The line along which the separation takes place is known as the *line of demarcation*; on the one side is the dried-up dead material, on the other the living tissues, reddened, slightly swollen, and more tender than usual, because, owing to the presence of an injury, there is more than the ordinary degree of repair required, and the circulation is quicker and more active.

It must be acknowledged that suppuration is rarely absent when the gangrene is of any size; but it is an accident and not essential. The slough, if the tissues round are healthy and uninjured, can be detached without the loss of a single leucocyte.

2. *Where the vitality of the structures near is impaired, but not very seriously.* At once this gives a foothold to pyogenic micrococci, which are always at hand and ready; suppuration takes place, and although the gangrene does not spread, the loss of tissue is greater than is accounted for by the slough alone.

(*a*) The general nutrition may be enfeebled from any of the causes already mentioned. A burn, which in a healthy child would heal without suppuration, may give rise to extensive ulceration in a person suffering from Bright's disease or diabetes.

(*b*) The local nutrition may be impaired, owing to the surrounding parts having been affected by the original injury. In frostbite, for example, part of the tissue is killed outright, but the vitality of the structures for long distances round is so enfeebled that they are unable to resist the onset of the micro-organisms. The same thing occurs in bad crushes and bruises; large subcutaneous extravasations of blood are very prone to suppurate, partly because of the tension, but partly also because the tissues round are injured and unable to hold their own.

(*c*) Other irritants may make their appearance and help to weaken the resistance of the still living tissues. These may be of the same nature as the original one, or different. Tension, for example, prevents a slough being detached without suppuration. Friction and want of rest do the same. Septic decomposition is still more powerful, the ptomaines it produces causing the death of the structures they touch to a depth that depends upon the activity of their nutrition. If healthy granulation-tissue has already been formed, the surface cells merely melt away; but if the part is badly nourished and its vitality depressed, either from constitutional causes or from the original injury, or if the poison can soak into the tissues along the lymphatics, the destruction may extend for an unlimited distance.

These causes lead to one result: the tissues round the slough are injured; their vitality is lowered, and they have lost the power of resisting the pyogenic organisms which gain access to them. The lymph that pours through the walls of the vessels melts away; the leucocytes perish and become pus-corpuscles; the plasma can no longer coagulate; the injured tissues undergo coagulation-necrosis, disappear, and add to the fluid already present; and by degrees a layer of pus is formed, separating the dead material from the living lymph which, as the surface melts away, is constantly renewed from the vessels round. If it is in the interior of the body, the slough is enclosed in an abscess, the micrococci having made their way through the blood-vessels or lymphatics, and having found a congenial soil in the damaged tissues that lie around it; if on the surface, it lies on the surface of an ulcer, and the pyogenic germs have, in all probability, reached it through the skin.

3. *Where the vitality of the tissues is very seriously depressed.* It is no longer now a question of molecular disintegration or ulceration; the surrounding part perishes *en masse*; the gangrene itself spreads.

The conditions under which this occurs may be classified in the same way.

(*a*) The general nutrition may be in fault. I have known gangrene extend from the foot to the thigh in both legs, and prove fatal within thirty-six hours, with all the symptoms of the most profound collapse, after two primary amputations, one on each foot, performed with the strictest antiseptic precautions. The vitality of the tissues, from the combined effects of Bright's disease, exposure, intemperance, and the carbolic spray, was so low that, uninjured, they were only just able to hold their own; the least hurt killed them at once, and the contact of the tissues already killed was a sufficient irritant to destroy the vitality of those around.

(*b*) The tissues may have been injured too seriously by the original cause. If amputation is performed for frostbite before the part has thoroughly recovered, the flaps are sure to slough. Their vitality is so low that they cannot withstand the additional hurt.

(*c*) Another irritant may be added and complete the destruction. Septic decomposition is the usual one. The ptomaines produced by this, if they are absorbed, act as the most powerful depressing agents, causing septic fever or sapræmia. If the tissues have already recovered from the original hurt, and are protected by a wall of newly developed vascular granulation-tissue, no ill-result follows; a slough on the surface of a healing ulcer causes very little disturbance, unless it is assisted by tension, friction, or other modes of irritation; but if there has not yet been time for this, or if the vitality of the part is too depressed, sloughing of the most extensive description is almost sure to follow.

As the greater includes the less, so, if the gangrene spreads, suppuration always occurs. Only as the pyogenic micrococci require time before they can produce much effect, in the worst form of spreading gangrene the tissues perish too soon.

The consequences of gangrene, in short, depend upon the state of the part that is living. If the tissues are healthy, uninjured, and well-protected, they are easily capable of resisting such an irritant as contact with dead material, and set about repair at once. If, however, they are weakened by constitutional or local causes, or if they are exposed to further injurious influences, mechanical or chemical, their power of resistance is enfeebled, and according to the proportion their strength bears to that of the combined irritants, either molecular or molar death follows—suppuration or gangrene—and spreads until it reaches a part that is capable of successful resistance.

Special Forms of Gangrene

Some of these are due to the action of infective organisms, others are not; but as the one nearly always complicates the other, it is not advisable to consider them apart.

1. Dry Gangrene.—The most typical example is that caused by *thrombosis* in atheromatous arteries, commonly known as *senile*.

It always begins in the lower extremities and can generally be traced to some trivial injury. For some time past the feet and legs have been peculiarly cold and numb; there has been a constant sense of itching and formication; cramp has been very painful in the calf; then suddenly a dark red or purple spot, surrounded by a dusky ring, is noticed, usually on the inner side of the great toe; and on examination it is found that the action of the heart is very feeble, that the tibial pulse can scarcely be felt, and that the arteries are rigid and hard. As a rule it is the seat of a constant burning pain, but sometimes this is not noticed. Gradually the central patch becomes darker, and encroaches on the areola round; this, without growing wider or narrower, slowly spreads farther and farther; the toe becomes shrunken, dried, and hard; and at length the foot is involved. Progress is rarely uniform; one toe after another may be attacked at intervals. Just below the ankle there is always a rest, sometimes a permanent one; but the tendency is for the disease to progress, sometimes slowly, sometimes quickly, until exhaustion, with extreme depression and low wandering delirium, sets in. *Post mortem* the arteries are usually calcareous, rough, and irregular on the inner surface, and blocked or narrowed by coagula, often as high as the popliteal.

Arterial *embolism* usually gives rise to the same form when it causes gangrene, but, as a rule, the collateral circulation enlarges sufficiently to prevent it. Exceptionally, either because several trunks are plugged at the same time, or the condition of the vessels round is such that they cannot dilate, the blood-supply is altogether cut off. It usually occurs after endocarditis. The onset is sudden; there is a severe attack of pain in the course of an artery, generally where it bifurcates or gives off one or more large branches; the part feels dead or numb, the temperature falls, the pulse below disappears, and then by degrees the skin passes through the same changes. Suppuration usually occurs while the dead part is being detached, because the living tissues next to it are too much injured to resist the action of the pyogenic micrococci. A certain amount of decomposition may be present, too, after this has taken place and supplied the necessary fluid, but so long as the general nutrition is good, there is little or no fever, and the death of the tissues is, except for the suppuration, limited to the original area.

Symmetrical gangrene (Raynaud's disease) is very similar to this in its local changes; but no lesion of any kind—embolism, thrombosis, or degeneration—has been found to account for it. Possibly it is due to arterial spasm arising from cold, and rendered persistent by a hyper-sensitive condition of the vaso-motor centres. It is usually met with in young anæmic subjects suffering from feeble circulation, and always attacks the extremities. In its slighter forms, cold, greyish-blue, ill-defined patches of local syncope or local asphyxia suddenly make their appearance after some trivial exposure, upon the hands or feet, or upon the pinna, very often symmetrically. After a time these may disappear, but occasionally the colour remains pale or livid, then turns blue and purple, and finally becomes black. In some instances it is associated with hæmatinuria.

Gangrene due to the direct effect of intense cold presents the same features (*frostbite*). The part is frozen through; the skin remains firm and white, and then passes through the same changes. This, of course, like all other forms, is more likely to occur when other causes, such as old age, starvation, fatigue, or exhaustion, exist; and moist cold is certainly worse than dry. It rarely happens, however, in England that the temperature falls sufficiently for this. Usually, frostbite is caused by the too early application of warmth to a half-frozen surface, and the gangrene is moist. Slighter degrees of cold merely lead to vesication, like heat, or superficial gangrene; and the slightest, to an erythematous state in which the skin is deep red or livid, and subsequently, when warm, becomes painful and slightly swollen.

Dry gangrene may also be caused by intense heat—the actual cautery, for example; but, as a rule, in cases of burning, the tissues for long distances round are injured to such an extent that inflammation and suppuration follow. Potassa fusa, applied as it used to be when it was desired to form an issue, produces the same result—a limited shrivelled patch of blackened tissue, unable to undergo decomposition owing to the absence of fluid, and surrounded by a zone of suppuration.

A very rare form of arterial obstruction, due to *endarteritis obliterans*, sometimes leads to the same result. I have known it occur in the vessels of the upper extremity, so that when amputation of the arm was performed, the brachial did not require ligature. The symptoms resemble those of steadily advancing thrombosis, attended with severe pain. Most of the cases have occurred after middle life, without any very obvious reason.

All these forms of gangrene resemble each other in being practically unattended by decomposition. A portion of tissue is killed, either by being entirely deprived of blood, or by the action of some external agent. It acts as a foreign body, almost inert, so long as no other irritant is allowed to appear. The surrounding tissues are uninjured, and at once, if their nutrition is sufficiently good, commence the process of repair. Unhappily, in the senile form due to thrombosis (the most typical and the most common of them all) it usually happens that the clot extends farther and farther up the artery, so that successive portions of the limb become involved and perish; and in any case the vitality of the part is very feeble. In other instances the blood-vessels round the injured area dilate; lymph pours out through their walls, new vessels are developed, and, by degrees, a layer of vascular granulation-tissue (forming the so-called line of demarcation) is developed round the whole of the buried surface of the necrosed tissue. If this is small and completely surrounded, it may be absorbed and disappear entirely; if it lies on the surface it gradually dries up, and is thrown off by the granulations beneath.

Suppuration is not necessary for this process, although, unless the necrosed fragment is of very small size, it is nearly always present. The pyogenic organisms gain access either through the air or through the blood-vessels or lymphatics. The plasma no longer coagulates, the leucocytes near the infected spot perish and form pus-corpuscles, and the walls of the vessels and the tissue, already organised, undergo coagulation-necrosis and melt away in the fluid.

2. Moist Gangrene.—This may commence as such, or it may be dry at first. Senile gangrene, for example, is very often dry until the calf is reached; then, owing to the greater amount of fluid, decomposition sets in.

Dry gangrene does not extend unless the original cause is repeated—unless, for example, the thrombus spreads higher up the artery. Moist gangrene, on the other hand, whatever the cause, spreads until it meets some structure sufficiently well-nourished to hold its own. The products of putrefaction, soaking into the living tissues near, lower their power of resistance, and if their nutrition is impaired in the least degree, or if the irritant is assisted by tension, want of rest, or any other cause, they must give way. If the conditions are exceedingly unfavourable, the surrounding tissues perish *en masse* (sloughing phagedæna and hospital gangrene); if not quite so bad, if their vitality is merely impaired instead of being destroyed, they become inflamed, and as pyogenic organisms are always present in such circumstances, melt away as pus.

Whether specific micro-organisms are present in many of these cases, as well as septic and pyogenic ones, is uncertain, and the difficulty is especially great in connection with such diseases as cancrum oris and phagedæna. None, however, has yet been proved, and, in the absence of this, it is more reasonable to assume that these diseases, attended with very characteristic and extensive destruction, are the result of the ordinary germs, acting under conditions peculiarly favourable to them: overcrowding, for instance, and poisoning by foul air, in the case of hospital gangrene; and syphilis in the case of phagedæna.

The simplest example of moist gangrene is seen in a lacerated wound. A portion of the tissue is killed, it remains for two or three days adherent to the surface, slowly changing colour, and then quietly drops off, detached from the part that is living by the vascular lymph thrown out. If it is very tough and hard—tendon for example, or bone—so that the blood-vessels are scanty and unable to dilate, the process may take weeks instead of days.

Bed-sores, due partly to pressure, partly to the irritation of urine and retained perspiration, are an example on a larger scale. The skin at first is reddened, then fluid collects beneath the epidermis; this gives way, exposing the corium; and the continued irritation and pressure combined soon cause it to slough. Decomposition sets in, and the poison so formed, added to the already existing causes, kills the tissues round until a part is reached where the vitality and power of resistance are sufficiently good.

Nearly all forms of gangrene that are dry at first end in this way. Even if the centre remains hard and resists putrefaction, suppuration occurs round the margin, and the pus provides a sufficient amount of fluid for putrefaction. Fortunately, as a rule, by the time this has happened the tissues around the slough have recovered themselves, and have erected a barrier of young and vascular granulation-tissue, which may lose its surface as pus, but nothing deeper.

When a limb is run over and crushed, or when a large artery gives way subcutaneously and cuts off the circulation by the pressure it causes (*local traumatic gangrene*), the changes are the same at first. Immediately after the accident the limb is cold and loses its sensibility, the skin is even whiter than natural, and is stretched and tense from the extravasation beneath, and the pulse cannot be felt. Then the colour gradually becomes dusky and livid, especially towards the lower part, to which the blood gravitates; purple and green patches make their appearance; bullæ form, filled with a reddish fluid; the epidermis is detached from the corium beneath; emphysematous crackling can be felt here and there, and the odour is most offensive.

The subsequent course, whether the gangrene remains local or begins to spread, depends upon which is the stronger of the two, the tissues that are still living or the combined irritants. If the size of the slough is small, the tension low, and the condition of nutrition good, the tissues soon protect themselves, and a line of demarcation gradually forms. If, on the other hand, the part involved is large, such as a limb, and the tension in it is high, the products of decomposition, unable to escape, spread into all the cellular spaces in the living structures near, and stream into the lymphatics, poisoning everything they touch, and causing intense inflammation. The local traumatic gangrene, assisted by decomposition, has begun to spread.

The worst example of *spreading traumatic gangrene* met with at the present day is that which sometimes occurs after compound fractures, especially those due to direct violence. There is everything to favour its occurrence and its extension: an enormous extravasation at a high temperature; a wound, so that decomposition can begin at once; the opening usually valvular, so that the tension from the hyperæmia that follows must be high; fractured, and often dead, bone, which in some particular way is exceedingly favourable to decomposition; and all the cellular spaces in the tissues round widely open still, with no protecting barrier of lymph. Under conditions such as these it is no wonder that, if septic decomposition once occurs, and the products are not allowed to escape, spreading traumatic gangrene of the worst description follows. The part swells more and more; the skin is tense, red, and burning hot; the loose cellular tissue on the inner side of the limb and along the great vessels is boggy and œdematous, filled with a sero-purulent fluid which rapidly decomposes and causes emphysematous crackling; the redness keeps spreading farther and farther, round the seat of injury it gradually becomes dull and livid, then the cuticle separates, the tissue becomes soft, and, if the patient live sufficiently long, the whole part decomposes.

As described above, if the vitality is already depressed from other causes, constitutional or local (Bright's disease, for example, or cold), spreading traumatic gangrene will follow even when the irritant is comparatively slight.

Local traumatic gangrene, unless the part is exceedingly small and the escape absolutely free, is always attended with fever. Even when there is only a lacerated wound with a few shreds hanging from it, there is some absorption, which diminishes as the tissues become by degrees able to protect themselves. In the spreading form, setting in at once, before the cellular spaces are closed, with an immense amount of poison and very high tension, the absorption is naturally excessive, and the constitutional disturbance may prove fatal in the first few days. In some cases the temperature rapidly runs up to 104° or 105° F.; the pulse is full and quick, and the respiration hurried and rapid. In others, and they are usually the worst, it scarcely rises at all, the pulse is small and feeble, the patient is delirious, the face is dusky, the tongue dry and brown, and the symptoms are typhoid from the beginning. If the patient survives the period of spreading gangrene, and the tissues gain the upper hand, resisting the further advance of the irritant, and throwing out a wall of vascular lymph, the fever begins to fall, especially of a morning, and assumes the remittent type, characteristic of suppuration without free exit for the pus.

Given local traumatic gangrene—a part of the body, that is to say, killed by injury of any kind—the consequences, whether a line of demarcation forms, or inflammation and suppuration set in, or spreading gangrene follows, depend upon the vigour of resistance offered by the tissues, and the degree to which they are protected from other irritants. If they are healthy constitutionally, and were not injured when the neighbouring part was killed, and are not injured by any other agent (tension, want of rest, or decomposition), lymph is thrown out, and repair is commenced at once. If they fail to a slight extent in one or more of these conditions—if, that is to say, their vitality is lowered—inflammation sets in and spreads until a healthier part, capable of better resistance, is reached. If they fail seriously—if their vitality is destroyed—the gangrene spreads.

Treatment.—The general principles are the same in all forms, but special measures have to be adopted in the case of some of them.

1. *Constitutional.*—There is always well-marked general depression; very often it is one of the predisposing causes, weakening the tissues and rendering them more susceptible to the action of injurious agents, and if not already present it always makes its appearance in the course of the disease. Everything, therefore, must be done to husband and maintain the general strength; food must be nutritious but easily assimilated, and given, therefore, in small quantities at frequent intervals. Stimulants are required to assist digestion, or, if the heart is weak and the pulse feeble, to maintain the circulation. Opium may be given to relieve pain and procure sleep. Fresh air is absolutely necessary, particularly if decomposition is going on, and special attention must be paid to any constitutional disorder that may be present, such as Bright's disease or diabetes. Very great care, however, is required in the matter of food, especially in the case of old people. It often happens that

for years past they have taken it in exceedingly small quantity, their strength being economised to the utmost by rest and warmth, and any attempt to increase it only defeats its own end. Under these conditions it is not uncommon to find that comparatively large quantities of stimulants, especially brandy, are very well borne; and, provided the surrounding temperature is carefully maintained, enable the patient to tide over the crisis.

2. *Local.* (i.) *Preventive.*—Sometimes when the onset is gradual the cause of the gangrene can be removed in time. The constriction may be divided, for example, in the case of a strangulated hernia or paraphimosis; the tension relieved by timely incision in phlegmonous erysipelas or cellulitis, and the pressure in bed-sores distributed over a wider area, or transposed to another part of the body altogether. In many cases, however—especially those in which the blood-supply is cut off—any measure of this kind must be too late.

(ii.) Where this cannot be done, an attempt must be made to stay the progress of the disease by preventing the repetition of the original cause and the access of any other.

The circulation must be assisted in every possible way. The part should be raised, so that veins and lymphatics can empty themselves with ease; the temperature kept perfectly even; and absolute rest enforced. Nothing answers so well as investing the whole limb in cotton-wool, which may be impregnated with some antiseptic to assist in checking decomposition; poultices should always be avoided, and wet fomentations, which, by the moisture they contain, encourage the softening of the epidermis. In some cases of senile gangrene, in which there is no surrounding inflammation, and the skin of the limb is not tender, gentle upward friction is of service, as it tends to empty the veins and increases the flow through the neighbouring tissues.

The least tension in any part must be relieved at once. Free incisions are often required, not only to reduce the pressure upon the skin, and prevent it sloughing, but, by giving exit to the pent-up fluids, to check absorption and allow the blood to circulate more freely. The wide gaping of the cuts, the continued draining from their edges not only of blood, but of inflammatory exudation, and the wrinkling of the skin on the following day, afford a very good explanation of the fall in the temperature and the diminution in the fever that always follow.

Decomposition must be prevented. This may be accomplished in various ways. In many forms of local traumatic gangrene—where, for example, the fingers have been crushed, and it is not known how much is hopeless—prolonged warm and antiseptic baths are most beneficial. If the part is only small, corrosive sublimate (one part in ten thousand) may be used for several hours a day at first, and then, when the putrefactive odour is overcome, for an hour night and morning. If the part is too large, so that absorption is feared, or if the patient complains of pain, boracic acid may be substituted, but it is not so efficacious. The injured part is dependent, it is true, especially when the lower extremity is concerned, but this disadvantage is fully compensated for by the relaxation of all the tense and inflamed tissues, by the regularity of the temperature, the free escape for the inflammatory exudation, and the impossibility of decomposition.

When, on the other hand, the gangrene has a tendency to become dry, absorbent dressings and iodoform should be used. Salicylic wool, wood-wool impregnated with corrosive sublimate moss treated in the same way—anything, in short, that checks putrefaction—succeeds in proportion to its power of absorption. The dressing, however, unless the gangrene is of the driest type, needs changing frequently, for fear that a solid mass of dried discharge may form like a scab over the ulcerating surface and keep the fluid beneath pent up. At the same time tension should be relieved by suitable measures, gentle compression, elevation, and even incision; and sloughs or portions of dead tissues removed as soon as they are loose. The greatest care must be taken, of course, not to injure or irritate in any way the protecting barrier of granulations: this has been formed by tissues that are only just able to hold their own, and no more; and the least damage done to them at once causes the sloughing to spread; but this is no reason why parts which are clearly dead, and which can be removed without injury to those around, should not be taken away as soon as they can.

As the line of demarcation forms and gradually grows deeper and more defined, the sloughs of the soft parts usually separate of themselves, until at length the bone is left with—hanging round it—tendons and dense sheets of fascia, which, owing to the anatomical condition of the circulation, are only detached after prolonged suppuration. Sometimes when this is the case the soft parts may be very gently retracted, lateral incisions being made to give more room, and the projecting structures carefully divided; otherwise the natural process of separation may take an immense length of time; but this should not be attempted until the spreading of the gangrene is no longer feared.

(iii.) *Amputation.*—In local traumatic gangrene—such, for example, as results from the rupture of a large artery, with or without fracture—amputation should be performed at once, sufficiently far above the seat of injury to secure healthy flaps. It means that the attempt made to save the limb has failed; and if gangrene begins, it is certain to spread as high as the seat of injury, and very likely not stop there. Nothing therefore is gained by waiting.

In spreading traumatic gangrene the conditions are different. If it is due mainly, or even in part, to constitutional causes, amputation higher up would be followed by the same consequences. In some very rare cases however, it is purely local, due to the presence of a poison retained under high tension, usually decomposing, extravasated blood; and then, it is just possible that amputation higher up, performed sufficiently early, would succeed; but in such cases as good a result may be obtained by free incision, relieving the tension and checking absorption.

In no other case should amputation be performed until the line of demarcation is well established; and even then, in the majority, it is wiser to wait until all the soft parts have separated and the wound so left is beginning to cicatrise. Excision of the projecting end of the bone, even with a certain amount of soft tissues round it, is a very much less serious operation than a formally planned amputation; and, unless the patient is being exhausted by suppuration, is always to be preferred. Owing to the conical shape of the stump left by gangrene, something of this kind is always required.

SPECIAL FORMS OF GANGRENE.—*Senile gangrene.*—Nutritious, digestible food, with a reasonable supply of stimulants; rest, elevation, and equable warmth, are here the most important measures. The part should be well sprinkled with iodoform, and then covered up thickly with many layers of cotton-wool. Care must be taken never to keep it exposed for any length of time, and not to allow hot water bottles too near. Poultices should not be applied under any circumstances. In this form of gangrene in particular, opium is of the greatest value, and it has been said that recovery or not may be foretold from the way in which the patient stands its administration.

Hutchinson has recently advocated high amputation (through the lower third of the thigh) in both the dry and the inflammatory form of senile gangrene: the limb is usually small and wasted at that point; the artery is sound in Hunter's canal; the flaps are well supplied with blood; and old people, as a rule, resent operation very slightly; their tissues are not prone to inflammation. The alternative is to let the part alone, confining the patient practically to one position in bed, until a line of demarcation has formed, leaving a very conical stump, which does not heal of itself, and which does not admit of being interfered with. Probably, in many cases, in spite of the apparent severity of the operation, such a measure is really advisable, not of course if the gangrene is limited to the toes, or even to the front part of the foot, but if it extends to, or in the least degree above, the ankle. If it spreads to the calf, even the driest form is exceedingly liable to become moist, and then the inflammation nearly always proves fatal.

In frostbite the greatest care must be taken not to warm the part too soon; if it is exposed even to a moderate temperature before the circulation has recovered, moist gangrene is almost sure to follow. Amputation should never be performed until the line of demarcation is deeply cut.

In that form which is due to embolism the same rule practically holds good, although an operation may be performed somewhat sooner; the surrounding tissues are not so badly injured. The constitutional disturbance, however, in these cases is very rarely severe, and the risk of septic absorption very slight.

PHAGEDÆNA

Phagedæna is an exceedingly rapid form of molecular disintegration or ulceration, chiefly met with at the present day in connection with syphilis. There is, in the ordinary variety, no sloughing, swelling, œdema, or extensive redness; simply the base and the edges of the ulcer affected by it become liquid and melt away. In another variety, however, which is much more rare, sloughing is present as well, the surrounding tissues becoming swollen, tense, and hard, and then gradually turning black. No specific organism has ever been proved to exist, and it seems more reasonable to assume that the ulceration becomes phagedænic because of certain predisposing causes, of which syphilis is a very important one. Exposure to cold and wet, privation and extreme youth are probably not without influence. In the vast majority of cases primary syphilitic sores that become phagedænic (sixteen out of seventeen according to my notes on the subject) are followed by secondary syphilitic symptoms.

Constitutional treatment is of very great importance. Phagedæna may arise in connection with syphilis in people who are apparently strong and otherwise healthy; but it is much more frequent in those who are broken down from long-continued exposure and intemperance.

When it is practicable, nothing succeeds so well as prolonged warm baths and iodoform; the former during the daytime, for from eight to ten hours, the latter dusted on at night. The ulceration nearly always ceases to spread at once, and the sore begins to throw out granulations. If this cannot be done iodoform may be used alone, or if the sore is in such a position—on the ala of the nose, for example—that it is absolutely necessary to stop the extension at once, the patient should be placed under an anæsthetic and the acid nitrate of mercury applied freely. The pain, which lasts for twenty-four hours, may be controlled to some extent by using a lotion of cocaine, renewing it frequently. Unless the existence of syphilis can be definitely excluded, a mild mercurial course (Hyd. c. cret. gr. ij., with Dover's powder night and morning) should be commenced without delay.

HOSPITAL GANGRENE

Hospital gangrene bears the same relation to ordinary traumatic gangrene that phagedæna does to ulceration; sometimes it is known as sloughing phagedæna. It is a form of gangrene which breaks out under certain conditions that used to be of frequent occurrence in connection with hospitals, and attacks every kind of wound, small as well as large. It spreads with the greatest rapidity and is intensely contagious. The surface of the wound is covered with micrococci, which extend deeply into the substance of the tissues, destroying them wherever they come in contact with them. Whether they are the ordinary forms of staphylococcus and streptococcus working under peculiarly favourable conditions, or whether they are specific, is not known; the former view is the more probable, as hospital gangrene never occurs except under certain conditions, and apparently never fails to be produced by them. Overcrowding and absence of ventilation will cause it everywhere; probably the intensely poisonous substances produced in these circumstances, soaking gradually into the tissues for days and weeks together, impair their vitality to such an extent that the ordinary germs are able to act with the most unusual energy and produce the most disastrous results. The general nutrition is in the same condition as that of the case already mentioned, in which gangrene of both legs followed after primary amputation of the feet, only the cause is a different one.

In connection with this it is noteworthy that sloughing cellulitis of the most intense description occurs in some cases of snake-bite, and in some forms of post-mortem poisoning, and, what is very significant, not always in the neighbourhood of the wound. In the former of these at least it is practically certain that the gangrene is due to the virulence of an alkaloid, which, though it is not sufficient to kill the tissues at once, lowers their vitality to such an extent that they fall an easy prey to the micro-organisms that enter from time to time into the blood. In the latter—when, for example, all the cellular tissue on the side of the thorax becomes gangrenous forty-eight hours after a punctured wound of the finger—the same explanation is highly probable; and it does not seem unlikely that hospital gangrene is really due to saturation of the blood with the scarcely less virulent poison thrown off by the lungs in cases of overcrowding.

PHLEGMONOUS INFLAMMATION

Diffuse inflammation of the cellular tissue and skin, the so-called phlegmonous erysipelas, is another product of the ordinary micrococci of suppuration acting under peculiarly favourable circumstances. In many respects it resembles true erysipelas, especially in the conditions under which it occurs, but in its nature it is essentially different. Like erysipelas, it usually spreads from a wound; those who are broken down in health from intemperance, exposure, and particularly Bright's disease, are much more prone to it than others; and in a very large proportion of cases a streptococcus is found in connection with it. But, on the other hand, it is not infectious, although it is in the highest degree contagious; it always ends in suppuration and sloughing; it may follow injuries of the most varied description: post-mortem wounds, bites of reptiles, or the sting of a wasp; it attacks deep-seated parts of the body, such as the pelvic cellular tissue after parturition or lithotomy; and it is never accompanied by the characteristic, well-defined rash always present in true erysipelas. The affection of the skin is an altogether secondary complication, which may, or may not, be present, according to the original seat of inflammation. Further, the streptococcus, which is undoubtedly the ordinary S. pyogenes, is not confined to the lymphatics, as in the case of the S. erysipelatis, but migrates freely beyond into the cellular spaces, and penetrates through the adventitia of the vessels into their interior.

Causes.—In some rare cases diffuse inflammation originates without a wound. Nearly always, however, an injury of this kind is present, opening up the submucous or the subcutaneous cellular tissue, or the deeper planes among the muscles or round the bones. When there is none, the germs—as in acute infective osteomyelitis—gain access to the part through the blood. Occasionally, the inflammation commences some little distance from the seat of infection; and exceptionally it does not attain any great degree of severity until this is healed.

The predisposing conditions are general and local. The former are those already mentioned in connection with gangrene, diabetes, Bright's disease, the consequences of exposure, intemperance, starvation, and, briefly, everything that tends to interfere with the elimination of waste products, or impair the general nutrition. Overcrowding and bad ventilation are very important in this respect; probably their influence is due to the poisonous substances exhaled from the lungs, which, even when breathed for a short time, produce the most extreme depression.

The local conditions are very simple: imperfect drainage, especially if there is a cavity filled with extravasated blood, is sure to cause it. It is for this reason that diffuse inflammation of the most disastrous character is so common after compound fractures or penetrating wounds of joints. Decomposition occurs under high tension before the tissues are able to protect themselves in the least, and the products are driven into the loose cellular interspaces, poisoning and destroying everything they touch. For the same reason the condition of the uterus after parturition, with an enormous development of cellular and lymphatic tissue in the region of the cervix, renders it particularly susceptible.

Bruising and tearing the structures round in performing an operation—in other words, lowering their vitality and filling them with extravasated blood—greatly increases the liability to it. It is partly owing to this, partly to the effect of renal disease, that diffuse inflammation of the pelvic cellular tissue is so common and so fatal after lithotomy when the calculus is a large one In other cases it is due to the local effects of virulent chemical poisons Diffuse cellulitis of the neck, for example, may result from the sting of a wasp, and sloughing over a very large surface has been known to follow the bite of a poisonous snake. Probably the alkaloid injected into the tissues lowers their vitality to such an extent that they are unable to offer any resistance to the micrococci, which are constantly finding their way into the blood. Whether the extremely fatal form of diffuse cellulitis which accompanies post-mortem wounds in cases of puerperal peritonitis, is due to a similar alkaloid, or whether, on the other hand, it is the result of septic infection (infection, that is to say, with a living organism) is uncertain. The fact that the virulence of the poison diminishes rapidly as putrefaction sets in is consistent with either view; the exceedingly early occurrence of the symptoms favours the former.

Symptoms. 1. *Constitutional.*—These vary greatly in severity. In the worst forms, such as those arising from post-mortem wounds, they are practically the same as in spreading traumatic gangrene. They assume a typhoid character almost from the first; there may be a rigor or a succession of chills: the temperature rises rapidly to 105° or 106° F.; the tongue is dry and brown, the skin burning hot, the face dusky, and the pulse so small and quick that it is scarcely possible to count it. Delirium may set in, sometimes with profuse sweating, within twenty-four hours, and the result may be fatal, from the most acute form of septic poisoning, within the first few days.

In pelvic cellulitis after parturition or lithotomy, the effect is almost as rapid, the patient sinking into a semi-unconscious, wandering state, with an irregular, feeble pulse, extremely high temperature, and the most profound nervous prostration. When the cellular tissue of the limb is concerned, where the poison is not so intense or the absorption so rapid, the symptoms are less severe, and usually assume the sthenic form, but the fever continues high and very irregular for days and weeks; the emaciation and exhaustion are extreme; there is always the danger of pneumonia and pleurisy, or, if the head or face is involved (particularly the orbit), of suppurative meningitis; and if the patient survives the period of sloughing and acute absorption, pyæmia not uncommonly supervenes, or hectic and diarrhœa follow, or the prostration is so great that some comparatively slight disorder sets in and proves fatal.

2. *Local.*—These naturally vary with the structure of the part, but the swelling is always very great, soft and œdematous at first, then becoming hard and brawny, and later, as the cellular tissue sloughs, softening again and becoming boggy. On the scalp it is usually due to wounds that open up the subaponeurotic layers; the œdema spreads rapidly over the vertex, extending down to the eyelids in front, to the superior curved line of the occipital bone behind, and the zygoma on either side. The skin is exceedingly tender, but there is very little redness; the glands in the neck are enlarged and swollen, and there is always intense headache and not unfrequently delirium. When it involves the orbit, the eyelids are immensely swollen, the conjunctiva is reddened and chemosed; the globe is pushed forwards and fixed, and the pain is most intense. If the symptoms do not soon subside, the cornea becomes opaque and sloughs; the eyeball is completely disorganised, and there is very great danger of the inflammation extending along the veins or lymphatics to the sinuses of the cranium or the meninges, leading to thrombotic pyæmia or acute meningitis.

Diffuse inflammation of the cellular tissue of the neck is no less serious. Usually it commences in the submaxillary region, caused, in all probability, by the absorption of some poison from the mouth. The swelling extends rapidly downwards, beneath the deep cervical fascia, giving rise to the most intense pain, with violent constitutional disturbance, and pressing upon the veins and the trachea. Sometimes even it reaches to the mediastinum and involves the pleura or pericardium. The skin is white and tense, the swelling exceedingly hard and very painful, and any movement is impossible.

In acute pelvic cellulitis the local symptoms resemble those of peritonitis, in which it often ends, except that the boundaries of the swelling are generally more defined. In the more chronic cases the uterus is fixed, and a hard mass is left projecting above the brim of the pelvis when deep pressure is made in the iliac fossa. If suppuration follows, the abscess may point in the iliac region above Poupart's ligament, or it may present in Douglas's pouch, or extend into the thigh, or the psoas muscle, or reach even as high as the kidney.

In the case of the limbs, diffuse inflammation nearly always originates from a poisoned wound, a punctured wound of a joint, or a compound fracture. Occasionally it occurs in connection with acute suppurative periostitis. When the deeper planes are involved, the skin is tense, white, and œdematous, but burning hot to the touch and exceedingly tender. Very often it is mottled with dusky red patches, which correspond to the places of communication with the deep veins. The pain is extreme, of a tense, throbbing character, and movement is out of the question. Usually the inflammation extends higher up the inner side of the limb than the outer, very often following the course of the large vessels ; and the neighbouring lymphatic glands are always enlarged and tender. When the part affected is the subcutaneous layer, the symptoms are, for the most part, the same, but the colour is a deep dusky red, shading off imperceptibly, not, as in erysipelas, with a sharply defined margin. At first the skin is soft and pits on pressure; then it becomes hard and brawny ; vesicles and blebs form upon the surface; the colour grows deeper and deeper, in one or two places it becomes almost purple, and then, here and there, it softens and becomes boggy to the touch. In other words, the subcutaneous cellular tissue has passed through the stages of extreme hyperæmia and exudation, and has sloughed ; in some places, if it is cut into, it is soft and gelatinous, distended with a sero-purulent fluid, which can be squeezed out of it, like water from a sponge; in others it has practically disappeared, and nothing is left but a sheet of pus, without any definite limits, mixed with the shreds and sloughs of the fasciæ and the tougher parts of the connective tissue. Later still, if no incisions are made, the skin itself perishes, cut off from all source of nutrition, except where some of the larger vessels enter it from the inter-muscular septa beneath ; here, in general, a few islets still persist in the middle of the destruction. In the worst cases, in which nothing has been done to relieve the tension, the fasciæ and muscles are bared and dissected away from each other, the joints are opened, the bones exposed, and the limb is reduced to a perfectly hopeless condition.

Prognosis.—The prognosis in the case of diffuse inflammation of the cellular tissue is always exceedingly grave. If the head is involved, portions of the scalp may slough, the pericranium may perish, and osteophlebitis, pyæmia, or meningitis follow. In the case of the orbit the danger is even greater, and at best the eye is almost sure to be destroyed. The inflammation may spread from the cellular tissue of the neck to the pleura or pericardium, or it may prove fatal from extending to the larynx. After lithotomy it is practically hopeless. Even when one of the limbs only is concerned the danger is very great. Osteophlebitis, lymphangitis, or pyæmia may follow at any time. The inflammation may spread to the neighbouring joints and lead to acute suppurative arthritis. The bones may necrose; the great vessels may be injured; and even when all these more serious consequences are escaped, the limb may be rendered useless and become a constant source of pain from the sloughing of the subcutaneous and inter-muscular cellular tissue. The wounds heal slowly; the cicatrices are adherent to the muscles or the bones, so that they are constantly breaking down; the lymphatics are destroyed; solid œdema sets in; and, even after the most successful treatment, the part is left stiffened, cold, congested, and practically useless for active movement for months and even for life.

Treatment.—In the most acute form of diffuse inflammation the prostration is so extreme and the heart fails so rapidly that very little can be done. Stimulants—ammonia, ether, and brandy—must be given freely as long as the patient can absorb them. Sometimes, when the constitution is otherwise healthy, and the effect is due to the local absorption of a chemical poison, it is possible to tide over the crisis, and under these circumstances enormous quantities may be given with very great benefit; but this is of no avail if the production of the poison continues. In cases that are less severe, in which the immediate danger is not so great, careful watch must be kept upon the pulse, and everything must be done to support the patient's strength. It must always be remembered that unless it is the result of some very grave injury, diffuse inflammation rarely occurs except in those whose constitutions are thoroughly broken down, whose strength is exhausted, and who have been accustomed to the free use of stimulants for years past; but, if possible, remedies of this kind should never be given alone, always in small quantities at a time, with beef-essence, milk, eggs beaten up, and other foods that possess a more lasting value.

The local treatment is no less important. Everything must be done to check absorption from the surface of the wound and diminish the tension. Cold is scarcely of so much value in these cases as in other forms of inflammation. The vitality of the part is already very feeble, and there is some danger of causing gangrene. If suppuration has not yet occurred, elevation and gentle elastic compression with many layers of cotton-wool may be tried; if, however, this stage is already passed, more good may be done by means of warm fomentations and long-continued warm baths, assisted by thorough drainage.

If the skin is hard and brawny, with severe pain and throbbing, incision should be made without hesitation. It is no use waiting until fluctuation, or even local softening, can be detected; they should be made before this, for the purpose of relieving the tension and allowing the inflammatory exudation to drain away. It is better to make them where the need is not absolutely certain than to leave them unmade. The depth to which they should be carried varies naturally with that of the inflammation; in most cases it is not necessary to do more than incise the deep fasciæ, and, as a rule, they should not be more than an inch and a half or two inches long. In planning them regard should of course be paid to the position of important structures and to the natural folds of the part. The hæmorrhage is not unfrequently profuse for a short time, but it can always be checked by the pressure of some absorbent gauze or other similar material. Afterwards warm fomentations may be continued, so as to encourage the discharge as much as possible.

Other incisions may be necessary after the inflammation has ceased to spread, for the purpose of releasing sloughs or to give better exit to the discharges; and then, as granulations spring up, every attempt must be made to procure cicatrisation as soon as possible. Some contraction is nearly always left, and often the tissues are extensively matted together, so that they remain cold and œdematous; but if the part is not hopelessly disorganised, very great improvement may generally be effected by constantly repeated massage, warm douches, and shampooing.

In the worst cases, in which the joints are involved, or the skin is extensively destroyed, amputation is very likely to be required; but it should not be performed until the acute symptoms have subsided.

PYÆMIA

Pyæmia is an infective disorder, caused by the ordinary pyogenic micro-organisms, and distinguished from the other affections to which they give rise by the unusual prominence of some of the clinical and pathological features—rigors, metastatic abscesses, and diffuse inflammation of the serous and synovial membranes in particular. It is not a specific disease; there is no evidence that other organisms than the ordinary pyogenic ones, the staphylococci and streptococci, are ever present. It is not even a disease of itself; it is merely the product of the ordinary germs that cause suppuration acting under peculiar conditions. If these organisms are rubbed into the skin so that the hair-follicles are affected, they cause boils; under other circumstances, where the subcutaneous tissue is especially dense, they give rise to carbuncles; when the tissues are poisoned, either by the products of septic decomposition, or by the ptomaine of a snake-bite, diffuse cellulitis follows; if syphilis is present, phagedæna may occur; if the body is poisoned by the inhalation of the exceedingly virulent substance thrown off by the lungs, hospital gangrene and sloughing of the most extensive character are produced; and under certain conditions they give rise to pyæmia.

The anatomical structure of the injured part is one. Pyæmia is especially liable to occur in injuries of parts in which there are large veins unable to collapse—such, for example, as the diploe of the skull, the medulla of other bones, and tissues infiltrated with inflammatory deposit. The method of dissemination is another, dependent to some extent upon this. In diffuse inflammation of the cellular tissue, the organisms spread either by means of the lymphatics, or in the connective-tissue spaces; in pyæmia, the vehicle is the blood itself. For this reason, too, the infection is not a slow and gradual process, in which the neighbouring tissues are overcome layer by layer in a widening circle, but immense quantities suddenly enter into the circulation, and are carried at once to a distant part. Another condition of very great importance is the presence of some foreign material in the blood-stream to cause embolism. The usual one is a fragment from some disintegrating blood-clot; but experimentally it has been shown that perfectly inert matter, which can only act mechanically, is quite capable of producing the same effect. The mere presence of pus-microbes in the circulation (unless the amount is so large that they of themselves act as an embolus) is not sufficient to cause pyæmia; but if particles of cinnabar are injected at the same time, so that they become impacted in the arterioles and injure the endothelial lining of the vessels, characteristic metastatic abscesses are produced. That form of pyæmia in which diffuse inflammation only occurs, without evidence of embolism, is distinguished sometimes as pyæmia simplex. In addition to these there are other conditions, less well known, which probably are not without influence; the sudden entry into the circulation, for example, of considerable quantities of broken-down blood-clot, causing fever; the development, in connection with the inflammation of bone, of substances which render the pus produced under these circumstances peculiarly offensive; possibly, the inefficient excretion of the ptomaines generated in the alimentary canal when the kidneys are diseased; peculiarities of the patient's constitution, &c. They do not cause the pyæmia themselves; they merely determine its outbreak instead of, or in addition to, other forms of suppurative inflammation occasioned by the same germs.

Defective ventilation; want of cleanliness; the use of ward sponges; overcrowding, especially the collection together of suppurating wounds, and, briefly, all the circumstances that favour the development of the other forms of infective disease, favour equally that of pyæmia.

Pathology.—The blood generally coagulates well; as a rule, there is a great increase in the number of white corpuscles, while the red ones show signs of disintegration, breaking up into molecules and forming irregular masses without running into *rouleaux*. Cocci may often be found in abundance, both free and in the white corpuscles.

Sometimes the wound is apparently healing well, although a certain amount of suppuration is nearly invariable. Much more frequently it is foul and sloughing, with an offensive or ichorous discharge. The veins running from it are usually filled with softened clot; the infective organisms spread from the surface of the wound to the cellular tissue round the vessels and invade their walls; as the intima is approached a thrombus forms, and spreads farther and farther along the interior in advance of the inflammation. If the tissues are healthy, this prevents general infection; organisation sets in, and the poison is shut off. If, on the other hand, the nutrition of the tissues is feeble, or the power of the germs unusually great, or a fresh injury of any kind is inflicted upon the part, degeneration follows instead of organisation; the clot softens and breaks down; fragments of it are carried off into the blood-stream; and with them the cocci which have gradually worked their way through the wall. When pyæmia starts from a wound that is healing without suppuration, or, as in acute suppurative osteomyelitis, when there is no wound at all, the thrombosis must be explained in another way. The micro-organisms of suppuration are of common occurrence in the circulation—at least, they can enter easily enough; ordinarily they are innocuous; the tissues are able to resist their action; if, however, nutrition fails, whether from constitutional or local causes, or the endothelial lining of the vessels is injured, at once they make good their hold, coagulation-necrosis begins in the vessels, thrombi are formed, and if the other conditions are favourable, pyæmia follows.

Intravascular infection of this kind may occur even in children who are to all appearance in perfect health. Probably in them it is rendered possible by some temporary depressing cause: want, injury, over-exertion, or exhaustion and fatigue. When pyæmia has already developed, it is of frequent occurrence, and thrombosis in distant parts of the body, especially in places that have been bruised or injured, with the attendant consequences of embolism and metastatic abscesses, is one of the usual symptoms.

Infection with pyogenic micrococci (whether they come through the walls of the vessels at the seat of injury, or enter in other ways), with its attendant thrombosis, leads to two kinds of abscess, one arising in connection with the veins and capillaries, the other embolic.

a. Of these, the former may begin either in the neighbourhood of the wound, or in some distant part to which the micro-organisms circulating in the blood have been carried, and in which they have been arrested. In either case, the process and the consequences are the same. Thrombosis sets in; a ring of coagulation-necrosis forms round the germs; liquefaction follows; the clot, and then the walls of the vessels and the surrounding tissues break down and melt away; and in a very short space of time an irregular cavity is formed, filled with a thin oily pus, coloured in general from the mixture of a small quantity of hæmoglobin, and surrounded by tissues that are undergoing disintegration as rapidly as they can. The suppuration is always diffuse; there is no evidence of organisation, and no sign of limitation anywhere. The connective tissue between the muscles melts away, leaving them literally dissected out by the pus; the synovial cavity of a joint, or a tendon sheath, is filled within a few hours; or one of the serous sacs is involved in the same way. In other words, there is diffuse inflammation of the cellular tissue, followed by suppuration and sloughing, as in the worst form of the so-called phlegmonous erysipelas.

b. Embolic abscesses occur in a different way. The thrombi in the veins, softened by the action of the micrococci, break down; loose particles are carried off in the blood-stream, and passing through the heart are driven into the vessels of the lungs. The smaller ones may pass through these, and then later be stopped elsewhere—in the liver, for example; the larger ones are arrested, generally at the bifurcation of a vessel, and give rise to embolic abscesses.

The effect of a non-infective embolus depends upon the arrangement of the blood-vessels. If the collateral circulation through the part is good, no ill-result follows other than the obliteration of a short segment of the vessel. If the blood-supply is entirely cut off, local anæmia and gradual disintegration ensue; but if, as in the case of the lungs, there is a condition intermediate between these two, the blood pours in from all sides, without strength sufficient to force its way out; the part becomes more and more congested; the walls of the vessels give way; the blood is extravasated into the tissues, and at length, when coagulation supervenes, the whole area is converted into a solid conical block. This is known as hæmorrhagic infarction. It is common in the lungs and spleen, the base of the cone lying towards the serous surface; but it never occurs in the liver or the subcutaneous tissue.

When the embolus is infective from the presence of pyogenic micro-organisms, the same result ensues, but almost at once coagulation-necrosis follows, the central portion becomes liquid, and in a very short time the whole area of the infection, and the tissues for some distance round, are converted into pus. The change is so rapid as to resemble gangrene rather than ordinary suppuration.

The pathological appearances in a fatal case of pyæmia consist therefore, with the exception of the changes in the veins, almost entirely of abscesses and suppuration, sometimes diffuse, sometimes embolic. Only one organ may be affected, or several; the abscesses may be all visceral, or all superficial. In some cases only one tissue is affected; in acute suppurative periostitis, for example, the lesions may be limited to the bones; in some forms of chronic pyæmia to the subcutaneous tissues; in others—those especially that occur after the acute exanthemata—to the joints. Pericarditis, due to infective embolism of the coronary artery is exceptionally frequent in suppurative osteomyelitis; pleurisy in otitis; and abscesses in the liver when the urinary organs are involved; but, except in this last-mentioned case, no satisfactory explanation for such coincidences is forthcoming.

Symptoms.—No wound is exempt; it may occur without one, but it rarely breaks out without distinct evidence of suppuration, or, at least, of the presence of pyogenic germs. Sloughing wounds, and those which are foul from the presence of septic discharges soaking into and poisoning all the tissues round, are naturally more liable than those covered with healthy granulations; and septic fever and sapræmia are nearly always present as well.

It may begin insidiously, the temperature becoming more and more irregular and the patient failing distinctly, without its being possible to say that pyæmia has set in; or all of a sudden an intense rigor may commence without warning, and the temperature rise at once five or six degrees. After this it may fall again, but the characteristic feature is its extreme irregularity; rigors may occur every day, sometimes with such even intervals as to suggest ague; two or three may be present in the twenty-four hours; or there may not be one for a week; but, as a rule, the temperature is always suggestive of them, sudden and rapid rises occurring here and there without external causes.

The pulse and respiration vary with the temperature, gradually becoming more rapid and powerless as the patient fails in strength; any sudden change in either by itself is suggestive of fresh local trouble. The expression of the face is always peculiarly anxious, especially as each rigor comes on. The conjunctiva is often distinctly jaundiced, and the colour is earthy, if not yellow. The tongue is red and smooth at first, later covered over with brown crusts; herpes is often present, leaving painful cracks and fissures in the lips; the teeth are covered with sordes, and aphthous ulcers are often scattered over the mucous membranes. Emaciation is generally exceedingly rapid, and in itself is highly suggestive; the breath, and sometimes the whole body, exhales a peculiar offensive mawkish odour; the skin is marked by fugitive erythemata of a dusky red; sometimes vesicles, and even pustules, form upon it; and in many cases it is exceedingly sensitive, the least touch causing the most intense pain. Delirium is not common, unless the temperature is continuously high, until the strength gives way. Vomiting often occurs with the rigors; albuminuria is present in a very large proportion; but diarrhœa is unusual.

In addition to these symptoms, which are dependent upon the changes in the blood, others arise from the local troubles. Any serous or synovial membrane may be affected; abscesses may form in any part of the body, deep or superficial; the viscera may be riddled with them; or they may be scattered through the subcutaneous tissue; and wherever they occur, they are always diffuse. Many of these cannot be diagnosed; metastatic abscesses in the lungs, for example, are always small, and cause but slight physical signs, while the nervous system is so depressed that the pain, even when it is severe, is scarcely felt. Local tenderness is always of very great significance; and in most cases it is essential to institute a thorough examination of the patient every day to make sure that no suppurating focus anywhere is overlooked.

Pyæmia varies very greatly in its intensity. In some cases—when, for example, it is due to acute osteomyelitis—it may prove fatal within the week, even before metastatic abscesses of any kind have been able to make their appearance. In others pericarditis, or some other lesion so grave as to imperil life, sets in almost at once. Sometimes, on the other hand, it is very chronic, lasting even for months, with occasional rigors and abscesses, which in these cases are limited, or almost limited, to the subcutaneous tissues. So far as the prognosis is concerned, a very great deal depends upon the locality of the secondary deposits. When the abscesses are superficial or confined to the joints, and when the fever does not run an extreme course, there is always the hope that recovery may follow, but at the expense of a long and tedious illness, with very likely one or more joints crippled and almost useless.

Treatment.—When once pyæmia has developed, it does not appear possible to cut it short in any way; all that can be done is to treat the symptoms as they arise, and prevent them from becoming themselves centres of fresh infection. Prevention, therefore, is all the more essential—first, to prevent the poison developing, secondly, to prevent its being absorbed.

Where it is practicable, every patient before operation should undergo a thorough course of preparation. It is a well-known fact that people in a robust state of health, taking active exercise, and consuming a large amount of food, are not nearly such good subjects for operation as those who have long been bedridden. Laid up suddenly their bowels become confined, their liver is congested, the urine is thick and high-coloured, and a certain amount of feverishness sets in.

The surroundings should receive the greatest attention. Ventilation should be perfect; nothing tends to such depression as the constant breathing of air that has been fouled; and absolute chemical cleanliness must be insisted on. Bed, bedding, instruments—everything, in short, that comes in contact with the patient—must be scrupulously clean. Outbreaks of pyæmia have been traced to the sudden disturbance of accumulations of dust, but in the majority of instances it is probable the actual vehicle of the poison is some material object.

A wound requires even greater care. Everything that tends to irritate the tissues in the neighbourhood—want of rest, tension, friction, or decomposition—lowers their power of resistance and makes them more susceptible. Where the drainage is perfect, so that the discharges escape at once, and the surface of the wound is kept dry, so that decomposition cannot occur, suppuration may follow, but it will be limited to the surface, and there is little or no fear of the pyogenic micro-organisms either finding their way into the cellular tissue and causing diffuse suppuration, or entering into the bloodstream and leading to thrombosis, softening, and metastatic abscesses.

Abscesses should be opened at once and thoroughly drained. Joints that are filled with pus must be treated in the same way, or irrigated with a continuous stream of water. At first, the cartilages and the synovial lining are unaffected, and if only the contents are evacuated in time, and no accumulation is allowed, the mischief may be prevented from extending farther, and a very useful articulation left. In many instances, however, either fibrous or bony ankylosis results. The same plan has been tried with the serous membranes, but it is scarcely possible to hope for success with them.

Quinine is of some use in controlling the temperature, and appears to check the onset of the rigors, and diminish their severity, but not to the same extent as in the case of urethral fever. Germicides taken internally are of no avail; secondary deposits make their appearance even when the urine is almost black from the absorption of carbolic acid. Salicylate of soda and antipyrin may be tried; and opium is always of use, both to relieve the pain and anxiety and procure sleep. The food should, of course, be as nutritious as possible, and the supply of stimulants should be guided by the condition of the pulse.

CHAPTER IV

DISEASES DUE TO INFECTIVE ORGANISMS—continued

2. Specific

ERYSIPELAS

Two kinds of erysipelas are ordinarily distinguished : simple cutaneous and phlegmonous. In the latter, however, the skin is involved secondarily ; the true eysipelatous rash is not present, and there is no question that the inflammation is due entirely to the ordinary forms of micrococci.

Erysipelas is an acute infective inflammation of the capillary lymphatics, caused by the presence of a micrococcus. The skin is, generally speaking, involved, but sometimes it commences on the mucous and even on the serous surfaces.

Cause.—A streptococcus can always be found in the lymphatic spaces at the edge of the extending inflammation, chiefly in the superficial part of the corium and the subcutaneous fatty tissue ; it is not present in the blood-vessels. Whether it is the same as the streptococcus of suppuration (S. pyogenes) or not, is still doubtful. According to Fehleisen, it is not ; by itself it never leads to the production of pus ; if this occurs it is always the result of a mixed infection. According to others, however, all the differences may be explained by the method or site of inoculation, the degree of attenuation, or the individual power of resistance. Morphologically they cannot be distinguished, although it is said the micrococcus erysipelatis is slightly the larger of the two.

It is very doubtful if the micro-organism can gain access otherwise than through a wound, but the smallest scratch or abrasion is enough. Exposure to draughts, sudden chills, the east wind, and the like, which are occasionally followed by an attack, and which certainly predispose to it, must be regarded as depressing agents, rendering the tissues more liable to infection. Erysipelas is occasionally epidemic, and probably may be conveyed by air or water ; but it is certainly contagious, and is especially liable to be disseminated by dirty hands or sponges.

The predisposing causes include everything which can either impair the general health, or weaken the power of resistance of the tissues in the neighbourhood of the wound. Among the former are included Bright's disease, intemperance in food as much as in drink, gout, exposure, and privation. Overcrowding, the continued breathing of air loaded with the exhalations from other people's lungs, want of cleanliness, and general neglect of ordinary hygienic principles, probably act in the same way ; they all appear to interfere with the elimination of waste material of one kind or another, and so prevent the perfect nutrition of the tissues. Mechanical irritation, want of rest, tension, congestion or œdema, and the presence of foul or decomposing discharges soaking into the neighbourhood of a wound, affect the surrounding structures, lowering their vitality, and rendering them less capable of resisting. Under conditions of this kind the tissues, which, so long as they are healthy, are able to prevent the entry of foreign organisms, and destroy, sooner or later, those that from some accident may have entered in, seem to lose their power of resistance altogether. Experiments in illustration of this have been performed by many observers. Chemical ferments, containing themselves no organic structure of any kind, have been injected into the blood, and in a very short time it has been found that micro-organisms were present in myriads.

One attack distinctly predisposes to another.

Pathology.—Micrococci, forming chains, are found abundantly in the superficial lymphatics of the skin where the rash is spreading, not where it is fading, nor where it has passed away; they are much more scarce in the interstices of the tissues (though these anatomically belong to the lymphatic system), and are scarcely found at all in the vessels of the part. The other local changes are merely those that are present in ordinary inflammation, dilatation of vessels, accumulation of inflammatory exudation, and of leucocytes.

In fatal cases the blood is usually said to be fluid and uncoagulated, staining the interior of the heart and vessels. The spleen is soft and diffluent, the kidneys are engorged, sometimes showing signs of a catarrhal or interstitial inflammation, and the lungs are much congested, the smaller vessels being plugged with granular masses, which are supposed to be produced by the disintegration of white corpuscles. A similar change has been described in the vessels of the brain.

Symptoms. 1. *Constitutional.*—These usually precede the local ones by some hours, occasionally longer. There is a rapid rise of temperature to 102° or 104° F. with chills, or even a rigor; vomiting, epistaxis, and in children convulsions, are of common occurrence. The skin is hot and dry, the tongue is coated with a thick creamy fur, the bowels are confined, and there is headache with general depression. The temperature usually continues high for three or four days, and then gradually sinks, assuming the remittent type, but as it rises again with every local extension its course is rarely uniform. In the worst cases the symptoms are of a typhoid character almost from the first; the eyes are jaundiced; the skin is a peculiar dusky yellow; the pulse is very small, frequent, and feeble; diarrhœa is often profuse and sometimes very offensive, albumin is present in the urine (perhaps owing to the catarrhal inflammation), and there is a constant, muttering delirium, which may be due to the plugging of the cerebral capillaries.

2. *Local.*—The redness nearly always begins at the margin of the wound, sometimes where the skin is continuous with mucous membrane, as at the angle of the eye, or on the mucous membrane, very rarely some distance off. At first it is a bright rose-red; exceptionally, and only in severe cases, it has a dusky tinge. The edge is irregular, but always sharply defined; even when the rash is advancing it always marches by steps, suddenly showing a well-marked border some distance off. The skin is swollen, œdematous, and pits on pressure. The raised margin can be felt, it is so clear. Where there is an abundance of loose cellular tissue, as in the eyelid or the scrotum, the swelling becomes enormous in a very short space of time, but the pain is very slight. When, on the other hand, the skin is tightly bound down, as over

the nose or the pinna, the colour is livid, the swelling slight, and the pain intense. Very often in these circumstances the epidermis is detached from the corium beneath, forming bullæ, which at first contain clear serum, but soon become full of pus. As the inflammation subsides, these burst, dry up, and form scabs; but there is no ulceration or destruction of the cutis. In severe cases the fluid they contain is stained with blood.

The neighbouring lymphatic glands are always swollen and tender; very often this is the earliest sign, and it is usually present before the blush shows itself. As the disease advances the redness involves one area after another, fading in the centre as it spreads by the circumference. Sometimes this continues for two or three days only, sometimes for much longer periods, until perhaps the greater part of the body has been traversed. Then the temperature falls suddenly, the last-formed red patch ceases to spread, the swelling disappears; the skin becomes wrinkled again, and the pain and tenderness disappear. Desquamation always follows a severe attack, and when the head is involved, the hair falls off, but it speedily grows again.

In rare cases, erysipelas is erratic, disappearing in one part and breaking out in another; and in very exceptional instances, metastatic, suddenly subsiding and attacking some internal organ instead.

Abscesses are uncommon, although occasionally the lymphatic glands break down and suppurate. Very often a relapse occurs, sometimes two or three, but they are rarely so severe as the original attack. Acute suppurative arthritis, meningitis, pleurisy, and peritonitis have been recorded as complications; and occasionally in erysipelas of the face the mouth and fauces become involved, leading to erysipelatous laryngitis and œdema of the glottis. Pyæmia occasionally follows it; and sometimes, especially after repeated attacks, a condition of solid œdema is left, which is very disfiguring when the face is concerned.

Diagnosis.—The sudden rise of temperature, with headache, vomiting, and constipation; the enlargement and tenderness of the neighbouring lymphatic glands; and the peculiarly sharply-defined margin of the redness, are characteristic. The last serves to distinguish it from simple lymphangitis.

Erysipelas commencing in the mucous membrane of the fauces resembles ordinary catarrhal pharyngitis, but is infinitely more severe. The constitutional symptoms are even more marked than in the ordinary cutaneous form, the throat is swollen and burning hot; the mucous membrane of the palate is thickened and of a brilliant red; the voice is lost; swallowing is exceedingly painful; and the glands at the angles of the jaw are enlarged and very tender. The prostration in these cases is usually extreme, and, in addition to the ordinary risks, there is always the fear of the inflammation extending to the larynx.

Prognosis.—The severity of the initial fever is no guide. At the extremes of life; when the head, face, or chest is involved; when the disease continues for any length of time; and particularly when there is old-standing nephritis, the prognosis becomes very grave. A dusky red, instead of bright eruption; jaundice; delirium; blood-stained bullæ; and a sudden rise in the pulse-rate, without strength, are very serious omens. In many cases broncho-pneumonia sets in and proves fatal; in others signs of congestion of the brain; in others, again, the symptoms resemble those of typhoid with diarrhœa; or the patient sinks from exhaustion, worn out by the long continued fever.

Treatment. 1. *Constitutional.*—It must always be remembered that, although the fever at the commencement of an attack may be sthenic, it tends very rapidly, to assume a typhoid character.

A purgative is nearly always required at first; even when there is diarrhœa it may usually be given with advantage, and particularly when, from the patient's appearance or habits, it is probable that the liver is congested. Afterwards the bowels may be kept gently open by means of effervescent salines. In the slighter cases nothing else is required, though quinine with mineral acids may be given to stimulate the appetite. In the more severe ones, where the tongue is dry and brown, and the pulse is losing its strength and fulness, bark and ammonia with ether answer better than anything. If the temperature is high, quinine or antipyrin may be given, but they appear to have little effect upon the disease. Perchloride of iron, which, according to some, acts as a specific when given in large and frequent doses, has in my hands failed completely. I have often noticed a distinct improvement when it has been left off and quinine and carbonate of ammonia substituted.

Stimulants are usually required, especially in the aged, and in those who are accustomed to them. The guide to their administration is the condition of the tongue and the pulse. They should always be given in small quantities at a time, and if possible with beef-tea, meat-jelly, milk, arrowroot, or other food that can be easily absorbed. The object is to sustain the action of the heart and supply it with strength until the activity of the poison begins to subside. Very often after the first day or two the patient will take liquid food readily, and then there is not the same necessity.

2. *Local.*—Many attempts have been made to check the spread of the micro-organisms in the tissues, but not with any great success. Injections of carbolic acid and of sulphocarbolate of soda are recommended. American surgeons are said to have used bromine vapour and creosote with advantage. Salicylic acid is reported to have succeeded when injected hypodermically; and many other germicides have enjoyed a local reputation. In most cases, however, it answers better to treat the symptoms. Strong antiseptics in particular should be avoided, as the additional injury they inflict upon the tissues may cause sloughing,

The burning pain can be relieved by excluding the air and using gentle pressure. Cold may be grateful to the patient, but care is required in employing it, for fear of lowering the vitality of the part too far. Oxide of zinc and starch are sometimes dusted thickly over the skin, but in many cases they cause intolerable itching. Extract of belladonna mixed with glycerine, and covered with a thick, soft layer of cotton-wool, is greatly to be preferred. Three or four coats of lead paint, mixed with glycerine to prevent its cracking, have a very satisfactory effect, partly no doubt owing to the absorption of the lead and its action upon the capillaries; but the ordinary lead lotion is equally good if evaporation is checked by using five or six thicknesses of lint. In very mild cases the surface may be painted over with a strong solution of nitrate of silver in ether, or with collodion, or tincture of iodine, though the benefit is probably due to the mechanical effect upon the epidermis.

Rest, gentle uniform pressure, and elevation, if the part will admit of it, are of material help in relieving the pain and inflammation. When the tension is extreme, it is sometimes necessary to make a few punctures: for want of this I have known the eyelids slough, but such circumstances are rarely met with in uncomplicated erysipelas.

SEPTIC INFECTION, OR TRUE SEPTICÆMIA

In the strict sense of the term this name should be reserved for an acute specific disease caused by a micro-organism which multiplies in the blood, so that the most minute trace can communicate it by inoculation, as in the case of anthrax. It is not of necessity attended by septic fever or sapræmia on the one hand, or by the local manifestations of pyæmia, thrombosis, embolism, or suppuration, on the other. The smallest wound is sufficient; there is a short period of incubation—eight or ten hours in acute cases—and the symptoms steadily increase in severity. Sometimes it is known as progressive septicæmia, to avoid confusion with sapræmia.

That such a disease can be artificially produced by pure cultivations in animals is beyond doubt. Whether it ever occurs in man by itself, so that it can be distinguished from all other troubles that are caused by infective germs, is open to question. It must be remembered that after the injection of a minute quantity of a chemical poison into the blood, myriads of micro-organisms make their appearance; and care must be taken not to mistake effect for cause.

It is possible that some of the exceedingly fatal cases of post-mortem wounds that occur in connection with puerperal peritonitis are examples of septic infection; but, on the other hand, it is by no means improbable that they are really due to sapræmia, the inoculation of a virulent poison (as happens sometimes from the bites of venomous reptiles) causing such extreme depression that the tissues either succumb at once, or are too much weakened to withstand the action of other germs. Other examples are fortunately very rare.

Pathological Appearances.—The changes found *post mortem* are practically the same as those in other acute specific fevers. Cloudy swelling is universal; the brain and pia mater are congested; the spleen is enlarged; and the number of white corpuscles in the blood apparently increased; but in the most acute cases there is nothing more definite. In those which have lasted a little longer, or in which the temperature has been very high, petechiæ may be found upon the skin and the surface of the serous membranes, and sometimes these and the lining membrane of the heart show evidence of acute inflammation. Unless, however, the endocarditis has distinctly assumed the ulcerative form, embolism does not occur. When the disease has lasted longer it is usually complicated by the presence of local inflammation.

Symptoms.—The wound itself may have been absolutely unnoticed, but usually it is inflamed and painful, and sometimes there is tenderness running from it in the direction of the lymphatics. Otherwise it shows no change. The general symptoms commence, as a rule, about eight or twelve hours after the injury, with the most overpowering depression; headache is extremely severe; there may be a rigor of great intensity, but very seldom more than one; the temperature begins to rise at once, the pulse is small and feeble from the first, the respiration is hurried and shallow, and in a very short time delirium sets in, and stupor and coma rapidly follow. The central nervous system from the first is entirely overcome. Sometimes there is a rash upon the skin not unlike that of scarlatina. Lung complications are of frequent occurrence. Diarrhœa may be present, and albuminuria after the first two days is almost invariable. Later, if the case becomes chronic, inflammation of the serous membranes, and of the endocardium, may set in, and various local troubles, with sapræmia and suppurative fever, may make their appearance.

The diagnosis from sapræmia is practically impossible, although septic infection is more probable when there is a distinct incubation-period. No other diseases occurring under such conditions ever cause symptoms of such severity.

Treatment is of little use. An attempt should be made to limit further absorption by the thorough application of caustics ; there is evidence to show that, in the case of some other acute specific and infective disorders, destruction of the seat of inoculation is of considerable benefit. Quinine and antipyrin may be given when the temperature is high, and stimulants—alcohol, ammonia, and ether—if the pulse shows signs of failing. Otherwise, nothing is of much avail ; the case usually terminates fatally in a few days.

ANTHRAX

Anthrax, or malignant pustule, is an acute infectious disease caused by a specific bacillus. Woolsorter's disease is the same thing under a different form, and so is the splenic fever of cattle.

The bacillus anthracis is the largest and most easily recognised of pathogenic organisms. It consists of rods, from five to ten micro-millimetres in length, abruptly cut at the ends, and capable, under suitable conditions, of producing spores which possess the most extraordinary powers of resistance : their tenacity of life is so great that catgut prepared for ligature in the ordinary way and kept in a dilute solution of carbolic acid has shown itself capable of transmitting the disease. It can grow in the tissues, or in the blood, or outside the body, provided there is a sufficient supply of oxygen and the temperature is kept up. Naturally those are most exposed to it who have to deal with hides, wool, &c. : tanners, dock labourers, woolsorters, and others, but it may occur in butchers, and there is evidence to show that it has been transmitted by flies.

The mode of entry is either through the skin—as in malignant pustule and some cases of malignant œdema—or through the mucous membrane of the respiratory or alimentary tract (woolsorter's disease). In the former case, characteristic local changes precede the clinical symptoms ; in the latter, the bacillus enters at once into the blood-stream, penetrating, so far at least as the lungs are concerned, between the uninjured epithelial cells. Each of these forms, as the infection spreads through the body, may be attended at a later period by the primary lesion that is characteristic of the other ; thus if the patient lives sufficiently long, malignant pustule may develop upon the skin in a case of woolsorter's disease, and secondary intestinal anthrax may show itself in the course of malignant pustule.

The bacilli themselves may be found in enormous numbers at the seat of infection, in the inflammatory effusion that is poured out round it, and in the fluid of the vesicles that lie upon it They are also present in the blood, especially where, as in the spleen, the circulation is slow ; and they exist abundantly in the ecchymoses that are found in the mucous membranes and under the serous coverings of the viscera.

The period of incubation is very variable—from a few hours to ten days, and even more—probably depending upon the dose and upon the facilities for general distribution afforded by the anatomical structure of the part. The mode of action is, to a certain extent, mechanical, but the chief effect is due to the production of some substance (an albumose in all probability) at the expense of the tissues. In patients who have survived, the bacilli have been found in all the excreta, and in one remarkable case, recorded by Davies Colley, they were still present in the urine a month after the man had recovered from the attack.

Recently it has been shown by Hankin that an albumose possessing similar toxic properties can be extracted from a cultivation of anthrax, and further, that minute doses of the same, given previously to inoculation, confer a certain degree of immunity, while large ones only hasten the result.

Morbid Anatomy.—The pathological appearances in the case of anthrax are very similar to those that occur in other forms of acute blood-poisoning. Decomposition is rapid, the blood does not coagulate, all the viscera are congested, the spleen in particular, and sometimes the mesenteric glands are enormously enlarged. There is a blood-stained effusion in all the serous sacs, and hæmorrhages are not unfrequently present in their walls. Ecchymoses are common on the mucous surface of the intestine, sometimes forming raised blackened patches, which are surrounded by a zone of gelatinous infiltration similar to that in the primary affection upon the skin, and occasionally sloughing has commenced already.

The seat of infection, if it is on the skin, shows no sign of suppuration; all the angry redness and much of the swelling disappear *post mortem*; the centre forms a hard blackened slough; round it the tissues are filled with a blood-stained fibrinous effusion; and farther away all the parts, sometimes for long distances, are infiltrated, œdematous, and dark with hæmorrhages. Bacilli are present in abundance throughout the whole infected area and in the ecchymoses.

Symptoms.—The constitutional symptoms, as in septic infection, are those of the most intense depression, whether the poison enters by the skin or the mucous membrane. In some cases, especially in malignant pustule of the face and neck, there is a delay of only a few hours; in others more than a week may pass: then the temperature begins to rise and becomes exceedingly irregular; shivering sets in, with general pains all over the body; the pulse becomes small and feeble; sometimes there is cyanosis, and occasionally severe dyspnœa from œdema of the glottis. General cramp, diarrhœa and vomiting are of frequent occurrence; sometimes there are convulsions, especially towards the end; or the patient becomes delirious and comatose. In other cases the symptoms are typhoid almost from the first. Death usually occurs from heart-failure, sometimes rather suddenly; or it may be caused by asphyxia, especially when there is œdema of the glottis; or by fever and general exhaustion. Broncho-pneumonia and enteritis are more prominent, as a rule, where the infection is internal; but often in these cases the course is so rapid, and the constitutional symptoms so severe, that the physical signs are insignificant in comparison.

The seat of infection when it is upon the skin—the so-called malignant pustule—is characteristic. A small, red, itching papule forms first. As the effusion increases this becomes a vesicle, filled with blood-stained serum, resting upon an indurated base. Soon the vesicle breaks or dries up, leaving a blackened central scab or slough. The effusion continues to increase; an indurated area, raised considerably above the surrounding level, is rapidly developed; the surface becomes a peculiar purple-red, and ring after ring of vesicles form upon it, round the central slough; then the œdema spreads to the tissues near, until sometimes the hard, brawny swelling and the peculiar dusky redness extend up the whole limb, or, if it is on the face or neck, spread over the whole surface of the upper part of the body, and to the deeper structures, especially the larynx, as well.

The black central slough continues to enlarge in most cases as the neighbouring vesicles fall into it, but no pus forms. There is always a little depression in the middle, probably from the drying up of the effusion, and this makes the areola round appear more prominent than it really is. The intense brawny hardness, the rapidity and extent of the œdema, and the peculiar rings of vesicles are the most striking local features, though these last occasionally are wanting. Pain is always peculiarly slight. In some cases, in which the infection has taken place, in all probability, from an internal surface, so that the organism gains access to the blood at once, and only involves the skin secondarily, the central papule and vesicle are wanting; there is merely an enormous, brawny œdema of the subcutaneous tissues, and then of the skin, appearing first in separate spots (which, as they increase in size, soon fuse together) and becoming covered with irregularly scattered groups of vesicles. The working of the organism is exactly the same, except that it begins from beneath and is widely spread from the first, instead of being superficial and local for a time. This variety is sometimes distinguished as malignant œdema.

Diagnosis.—There is no difficulty when the local signs are well-marked. The central purple depression with the indurated dusky base, covered with rings of vesicles and surrounded by wide-spreading œdema is distinctive. In addition, the peculiar absence of pain in the earlier stages of the disease is most noteworthy, and separates it at once from ordinary forms of carbuncle or diffuse inflammation. Internal anthrax and malignant œdema are not so easy, although it may be clear, from the extreme constitutional depression, that there is some very grave form of blood-poisoning. Ordinary broncho-pneumonia or gastro-enteritis seldom causes such intense prostration and cyanosis; and the comparatively slight development of the physical signs by the side of the condition of the patient is very suggestive. But in the absence of local evidence it is only possible to determine the particular form of blood-poisoning that is present by a reference to the occupation and surroundings of the patient, or, better, by a microscopic examination of the blood. The bacillus is of such size, stains so readily, and is so distinctive and so widely distributed, that it can scarcely be overlooked.

Prognosis.—In external anthrax, if the seat of inoculation is excised or destroyed sufficiently early, the prognosis is fairly good. Recovery has followed even when the patient was already so infected that bacilli were present in the sputum, urine, sweat, and fæces (Davies Colley). Apparently the focus of inflammation acts as a laboratory, from which the poison is discharged into the system. In woolsorters' disease, where the stress of the complaint falls upon the intestinal or pulmonary mucous membrane, and when the face or neck is involved, or the œdema is wide-spread, and shows a tendency to involve internal organs, such as the larynx, there is much less hope.

Treatment.—If the infection is local, the whole thickness of the skin and cellular tissue should be excised, with an eighth of an inch of the cellular tissue round. Then, if there is any ecchymosis or œdema visible on the cut surface, the actual cautery, or potassa fusa, should be applied freely. When the œdema is too extensive for this, all that can be done is to inject hypodermically, all round it, a solution of carbolic acid (1 in 20), in the hope that it may soak into the tissues. Free incisions at the same time should be made into the subcutaneous tissue, and the wounds irrigated with a similar solution, or one of corrosive sublimate.

Sulphite of sodium, in ten-grain doses, is said to be very successful in animals, and should therefore be given a fair trial. Quinine has been recommended, and also corrosive sublimate. Of course the diet should be good, and, if necessary, stimulants given freely.

GLANDERS

This is another variety of infective disease, caused by a specific germ, the source and character of which are definitely known. Like pyæmia, anthrax, tubercle, and, to a less extent, syphilis, it varies very greatly in different cases, the severity of the attack and the nature of the symptoms being modified by the anatomical structure of the seat of inoculation, the method of dissemination, and probably the dose of the poison. It may be acute or chronic; it may affect especially the mucous membrane of the nose and the respiratory tract (glanders), or it may spread slowly in the cellular tissue and lymphatics (farcy); and, not uncommonly, after continuing in the chronic form for a greater or less length of time (I have known it upwards of a year in a horse), it suddenly becomes acute; but in all cases, although its manifestations and its course are almost as variable as those of tubercle or pyæmia, it is one and the same disease, caused by the same species of organism.

The bacillus is a small rod, somewhat shorter and thicker than that of tubercle, and usually exists in pairs. It is doubtful if it is capable of spontaneous movement, and it is questionable if spores exist. Usually it enters through wounds, especially at the corners of the nails; but, in all probability, it possesses the power of infecting the respiratory, if not the alimentary, mucous membrane. It may be transmitted from man to man, but, as a rule, it is caught directly from horses, or asses. Other animals show varying degrees of susceptibility to it.

Local changes are usually produced at the seat of inoculation; there is a period of incubation of some days, then the part becomes red and swollen; the skin breaks down, and a foul ulcer is left, spreading at its edges and its base, but without anything in itself characteristic. From this the organism spreads, with more or less rapidity, in the cellular tissue round, in the lymphatics, or in the blood, the severity of the symptoms, and the acuteness of the attack depending to a very large extent upon this. Wherever it spreads it causes inflammation; granulation-tissue is produced; and this, as in the case of tubercle and syphilis, undergoes caseation (unless it is near a mucous or cutaneous surface, when it may break down at once), so that yellowish-white, cheesy nodules and tubercles (farcy-buds, when they can be felt from the exterior), are formed in various parts. Suppuration follows, whether through the action of the specific bacilli, or because of the presence of pyogenic organisms in addition, is not known; and then ulcers, abscesses, and diffuse forms of inflammation break out in all the infected regions. The bacillus exists in the cheesy masses and in the pus; not unfrequently it can be found in the blood as well in man, but this does not seem to be the case with horses.

Symptoms.—It is met with, naturally, chiefly among those whose occupations render them liable to infection, and it may be acute, so that it proves fatal within three or four days, or chronic, lasting for months, and possibly ending in recovery after a long and severe illness.

The constitutional symptoms depend upon the acuteness of the attack. In the worst cases they resemble those that are always present in intense blood-poisoning—muscular tremors, low muttering delirium, &c., with high fever, and a small feeble pulse. When it is less severe they depend practically upon the number, size, and situation of the abscesses and ulcers, and upon the extent to which suppuration and septic absorption take place. In the majority of cases that do not terminate fatally at the commencement from the intensity of the fever, either broncho-pneumonia sets in from the constant inhalation of the odour from the foul and decomposing sloughs, or the patient sinks at length from exhaustion, utterly worn out by pain, inability to take food, profuse suppuration, and fever. The most chronic cases recover, but always seriously crippled.

Glanders may commence with inflammation and ulceration of the mucous membrane of the nose, or this may occur later in the course of the disease. In the case of the former, it is probably due to direct infection. At first there is a thin, profuse, watery discharge; this rapidly becomes purulent and exceedingly offensive; the inflammation spreads, and becomes more and more severe; the whole of the mucous membrane of the nose ulcerates and sloughs; the bones are exposed and bare, already eaten away in places; the eyes, the frontal sinuses, the antrum, the pharynx, and palate are rapidly involved; and the whole of the face and neck become swollen, livid red, hot, and inflamed, as in the worst form of phlegmonous erysipelas. Such cases usually prove fatal at a very early period; one, that I have seen, terminated on the fourth day from the commencement of the outbreak.

In the chronic variety (farcy) the distribution of bacillus takes place chiefly by the lymphatics; nodules form in the skin, the subcutaneous tissues, along the course of the lymphatic vessels, and then, later, in the internal organs. On the skin they appear first as minute papules scattered in irregular groups; these soon enlarge into pustules; the base upon which they rest becomes reddened, hardened, and infiltrated, and then they break, leaving foul, irregular ulcers. In the subcutaneous tissue the same changes occur, only the so-called buds usually attain a larger size before suppuration sets in, and the same thing is met with in the viscera and the lymphatic glands, the symptoms naturally varying with the number, size, and situation of the abscesses. Probably, after a time, dissemination takes place, as in pyæmia, by the blood-stream as well.

Diagnosis.—Acute glanders can hardly be taken for anything else. The chronic form, on the other hand, may remain uncertain for a considerable time, a certain amount of fever, with vague flying pains, being associated with a cutaneous eruption, and the formation of lymphatic nodular swellings in many other disorders—syphilis, tubercle, pyæmia, &c. The steady persistence with which the swellings form, enlarge, and break down in spite of everything, must soon, however, attract attention.

Treatment.—This is similar to that of anthrax; the seat of inoculation should be thoroughly cauterised, and if the mucous membrane of the nose is involved, the whole cavity should be irrigated with carbolic acid, corrosive sublimate, dilute sulphurous acid, or perhaps sulphite of sodium. Abscesses must be opened and treated in the same way, and the general strength must be maintained as well as possible. If the nose is not infected great care should be taken to prevent it. Probably this takes place in many cases secondarily, and is due to the patient himself conveying the poison to the mucous membrane. Recovery after this has happened is very rare.

ACTINOMYCOSIS

Actinomycosis is a disease caused by a peculiar form of fungus that attacks herbivorous animals (including man), gaining access to the tissues, either through wounds or through the mucous membrane of the respiratory or alimentary canal. There is some evidence to connect it with rye, and perhaps with barley. An epidemic occurred in Seeland, from eating rye grown on recently reclaimed ground, and on two or three occasions the disease has distinctly originated in a wound of the mucous membrane of the mouth, caused by a grain of rye, showing that at least it may be the carrier of the infection. In cattle it usually begins in the tongue or the jaws, generally the lower, and spreads thence to the cellular tissue of the submaxillary and cervical regions.

The fungus itself is easily recognised by its characteristic star-like masses of mycelium. The granulation-tissue that forms the tumours, and the pus in the abscesses and ulcers, contain myriads of yellow, rounded bodies like millet-seeds. Each of these is made up of little threads, which radiate, star-like (whence the name), from one common centre, and, after a time, enlarge and terminate in club-like structures, which probably contain spores. In cases of suppuration, however, these are not always plain, and the colour is not always so clear. Nothing is known with regard to its life-history, except that it has been found in the muscles of a pig, and that water and dilute saline solutions destroy it at once.

Infection usually takes place through the mouth, either from a wound or through some carious tooth; but the fungus has been found in the tonsil, and as a primary growth in the tubular glands of the mucous membrane of the large intestine. Cutaneous wounds are occasionally affected, and from the fact that it has been found abundantly in the cavities in the lungs, and in the pus from mediastinal abscesses, it is highly probable that, sometimes at least, the spores are inhaled, and sinking into the alveoli of the lung, set up broncho-pneumonia. Wherever it comes it causes chronic inflammation, which closely resembles that caused by tubercle, at least in its histological features. Giant-cells develop round the fungus; outside there is a meshwork, filled with epithelioid cells, and outside these again, others resembling leucocytes. Caseation soon begins in the middle; and the nodules formed in this way continue to enlarge at the margin and decay at the centre, until, like tubercle, definite caseous masses, which sooner or later break down into pus, are formed at all the infected spots. Suppuration is probably always due to the coincidence of pyogenic germs, for occasionally nodules of very considerable size are found intact. As soon as it breaks out the disease assumes a much more rapid course, the constitutional symptoms become more severe, and septic fever, hectic, and very probably pyæmia (the particles of the fungus serving as the embolus), make their appearance as well.

Symptoms.—The disease at the beginning is usually chronic. Enlargement of the lower jaw, or an ill-defined swelling in the submaxillary region, or a reddish but painless nodule upon the skin, is often the first sign noticed; and, for a time, there is nothing to distinguish it from all other forms of slowly-growing granulation-tumours. Wherever it is, it grows steadily, not involving blood-vessels or lymphatics at first. Then, sooner or later, suppuration begins; the pain and swelling rapidly become much worse, the size increases, the skin becomes red and glazed, and the constitutional symptoms become as severe as those of infective cellulitis or diffuse osteomyelitis. Secondary deposits soon follow, and, as might be expected, no organ in the body is exempt; caseous nodules, and abscesses containing the characteristic millet-seed bodies, having been found nearly everywhere, even in the brain.

Diagnosis.—The only certain diagnostic feature is the presence of the characteristic mycelium. When the teeth are attacked, the disease can usually be recognised before it has gone too far; one after another becomes loose and carious, and the cavities that result from their extraction are filled with masses of granulation-tissue breaking down into pus. In other cases, however, especially when there is merely a slowly-growing subcutaneous tumour, there is nothing at first distinctive about it. It is impossible to diagnose it from other diseases that lead to the production of masses of granulation-tissue, and from sarcomata. The prognosis, especially if the whole seat of infection can be removed in time, before suppuration has occurred, is very good. In some cases the disease has been very chronic, lasting for years; in others, however, it rapidly becomes disseminated all over the body, often being complicated with true pyæmia, and proves fatal either from some vital organ becoming involved, or from exhaustion and suppuration.

TUBERCULOSIS

Tuberculosis is an infective disorder caused by a specific micro-organism which gains access to the body either through the skin or the mucous membranes, and gives rise to characteristic changes.

The bacillus occurs in the shape of very thin non-motile rods, from two to eight micro-millimetres in length, and is found abundantly in the interior of the giant and epithelioid cells that constitute what is known as a tubercle. It is not present, with rare exceptions, in caseous *débris*, or the liquid material that fills caseous abscesses, although this is intensely infective. The probable explanation is that spores, which are formed in the body and which have the appearance of vacuoles when seen under the microscope, are present, but are not stained by the ordinary reagents, and consequently are not recognised.

That this bacillus is the cause of tuberculosis, and the only cause, must be considered proved: it is always found in connection with tubercular deposits; it does not occur without them, and inoculations with a pure cultivation practically invariably give rise to local or general manifestations of tuberculosis. As, however, the changes that occur and the results that follow present an immense variety, it is clear that there are other causes modifying its action.

Predisposing causes.—In large towns and in large institutions, especially where there is overcrowding, the tubercle-bacillus must be practically of universal distribution; yet only a few are attacked by it, and of those who are attacked a great many recover from it. It can only thrive in those who are in some way susceptible, whether this susceptibility is due to local or constitutional causes.

Heredity is of some consequence. There is no doubt that when full allowance is made for the effects of surroundings, the members of some families are much more subject to tuberculosis than those of others. This tendency was, at one time, known as scrofula, and certain personal peculiarities were supposed to be associated with it; but as the name was allowed to include both the constitution which indicates a predisposition to the formation of tubercle, and the effects of the disease itself, it is better to drop it altogether. If its etymology is taken into consideration, it should be confined to those cases in which, from the thickening of the tissues of the neck (caused by the glandular enlargement), the hypertrophy of the upper lip, and the diminished prominence of the chin, the profile bears some resemblance to that of a pig.

The *general conditions of life* are probably of much greater importance. Everything that tends to lower the vitality of the tissues, overcrowding in particular, uncleanliness, bad food, exposure to cold and wet, or want of exercise and fresh air, increases the liability. On the other hand, the children of tubercular parents, even when they themselves are already the subjects of the disease, may recover, and, in many instances, completely regain their health, so that there is no evidence of the disorder but the scars it leaves, if they are removed sufficiently soon to a proper climate and fed sufficiently well.

Age again is not without influence. Tubercular inflammation may occur at any time of life, even in old age, but it is very much more common among the young; and it is especially prone to attack those parts of the body which are at the time the seat of special functional activity—the lymphatic glands and the bones in youth, and the testes in adult life.

Every organ of the body may be attacked, although it is very much more frequent in some than others. True tubercular ulceration is not common upon the skin, independently of lupus and anatomical tubercle, which are due to the same cause acting under special conditions. (Lupus, that is to say, always gives rise to tuberculosis when inoculated in animals, although the converse has not been observed; and bacilli apparently identical have been found in anatomical tubercle of the fingers.) In the subcutaneous tissue it forms cheesy nodules, which break down and leave sinuses lined with tubercular granulations. The mucous membranes of the respiratory, alimentary, and genito-urinary tracts are often attacked by it, the lymphoid follicles enlarging and breaking down so as to leave superficial ulcers which slowly extend in depth and breadth until huge, ragged excavations are formed. The serous sacs are specially favourite seats for it. The synovial membranes of joints may be converted into gigantic masses of soft gelatinous granulation by it. The bones, especially in children, are often involved, and not unfrequently the disease, which usually begins in the growing layer between the epiphysis and the shaft, spreads from it to the joint. The lymphatic glands naturally rarely escape, while all the viscera are more or less subject to it; the mamma, ovaries, thyroid gland, and the voluntary muscles being curiously free.

Local predisposition to tubercle may be acquired as well. If the vitality of any part of the body is impaired by injury, inflammation, over-use, &c., the tubercle-bacilli, supposing they gain access to it, have all the better chance of living. It is owing to this, among other reasons, that it is so often localised in joints, and that tubercular disease of the lymphatic glands of the neck is so frequent. It may, of course, be that the common form of eczema of the head in children which causes this enlargement is itself tubercular, and that the lymphatic glands are infected as a natural consequence; it is said, in proof of this, that tubercle-bacilli have been found among the epidermic cells; but it is scarcely possible that this is true of the carious teeth and of the inflamed and enlarged tonsils which are not seldom the starting-point. It is enough that some slight irritation is excited in a lymphatic gland by the quantity or quality of the lymph passing through it; if once the tubercle-bacilli gain access to it—and they easily may through any abrasion—they are able to grow and thrive and prove the focus for a fresh dissemination.

Other circumstances, which cannot be called predisposing causes, modify the effect of the bacilli to a very considerable degree.

The dose is of importance. A single bacillus is probably enough. It is taken up by a leucocyte; this wanders some little distance in the tissues, and then, under the influence of the irritation, becomes transformed into a giant-cell, in which the bacillus multiplies. Clearly, however, the effect is likely to be much greater and more rapid when the infection is either a large one or frequently repeated; as when a patient continues to breathe air loaded with germs. As a rule, infection with small quantities gives rise to local manifestations.

The method of infection is another point. There can be now no doubt as to the possibility of infecting recent wounds. Many cases have been recorded in which wounds have gradually developed into tuberculous ulcers from which the bacilli have spread along the lymphatics to the neighbouring glands. The period of incubation is said to be about three weeks; a red nodule forms at the point of inoculation; it slowly increases in size; the centre breaks down, discharging a minute caseous mass, and a typical tubercular ulcer is left, with raised, reddened, and irregular edges, sometimes covered with granulations, and an uneven base, inclined to bleed. In most cases, however, the bacilli enter the cellular tissue directly, either through inflammatory abrasions of the surface, as in eczema capitis and otorrhœa, or in the case of mucous membranes, even without this. In the lungs it seems probable that they may develop first in the epithelium that is heaped up in the alveoli in pulmonary catarrh.

The dissemination is chiefly regulated by the *anatomical structure of the part.* The bacilli may spread slowly in the surrounding tissue, and the seat of infection enlarge continuously without involving other structures. They may be carried into the lymphatics, and arrested for a time or even permanently in the glands. They may get into the blood-stream and rapidly spread all over the pulmonary or systemic circulation; the wall of a vein may be ruptured by some accident, or torn in some operation, or the tuberculous focus may gradually ulcerate through it and burst into the interior. The same thing may occur with one of the arteries, though much more rarely; and finally, if the lining membrane of one of the serous or synovial cavities is attacked, the infection may spread rapidly over the whole surface.

The presence of a mechanical embolus, although it may not be of so much importance as in the case of pyogenic micrococci, when in all probability it determines the formation of metastatic abscesses, is certainly of consequence in connection with tubercular arthritis. It is not uncommon to find that this has originated from a wedge-shaped sequestrum in one of the articular ends of the bones; and it is a fair suggestion that cutting off the circulation and lowering the vitality of the segment is of very considerable assistance to the development of specific germs.

As the action of pyogenic organisms is materially assisted by the *presence of septic decomposition*, the ptomaines formed by this soaking into the tissues, lowering their vitality, and rendering them less capable of resistance, so it is with tubercle-bacilli. If suppuration occurs in connection with a tuberculous cavity, the process of destruction becomes exceedingly rapid. On the one hand the pyogenic organisms grow with greatly increased vigour in the tissues that have been weakened by the tuberculous process; on the other, the risk of general dissemination is very greatly increased by the possibility of the walls of the vessels giving way.

Pathology.—Tubercle-bacilli, wherever they are implanted, at once set up chronic inflammation of a somewhat special character. The earlier changes are the same as with any non-pyogenic germ; the capillaries dilate, more plasma pours through, and the leucocytes collect in larger numbers. Then, however, an enormous multinuclear cell develops at each point of infection, so peculiar in its appearance that for a long time it was believed to be a formation special to tuberculosis.

The most typical tubercles are the youngest, those which are firm and grey, standing out from the tissues around as minute, but distinctly circumscribed, masses. Each of these is made up of smaller ones, containing in their centre a giant multinuclear cell, and sending out in all directions processes which branch and form a kind of network. In the meshes, round the central mass, lie other cells, known from their general appearance as epithelioid; and these in their turn are surrounded by numbers of smaller ones, identical with ordinary leucocytes. In this, however, there is nothing peculiar but the regularity of the arrangement. Structures precisely similar may be produced by other causes than tubercle-bacilli; similar giant-cells can be found in any chronic inflammation, especially those forms which are poorly supplied with vessels; and they are surrounded by similar groups of epithelioid and lymphoid corpuscles. The specific character is due to the tubercle-bacilli, which can be found in the central mass, and in and between the epithelioid cells.

The semi-translucent, grey, non-vascular nodules formed in this way are typical of tuberculosis. Sometimes, in the infiltrating form of growth, they cannot be recognised in the masses of round-celled granulation-tissue thrown out as a result of the continued irritation; but, as a rule, they can be found forming a ring round the margins of growing tubercles, invading all the tissues near, and spreading into the lymphatics.

As soon as the nodule is developed, the central portion begins to degenerate, probably killed by the ptomaine excreted by the bacilli. Fatty degeneration and caseation follow, and as the infiltration continues to spread at the margins and decay in the centre, enormous masses of what is sometimes called crude or yellow tubercle are formed, the centre soft and cheesy, the margin consisting of typical grey nodules, which keep spreading as the part already formed degenerates.

The subsequent progress depends partly upon the relative vigour of the tissues, partly upon the anatomical structure of the area involved, and the opportunities for dissemination afforded the bacilli.

What is known as *obsolescence* may occur. The bacilli, unable to make headway, gradually cease to extend, and perish. The outer wall of leucocytes thrown out by the healthy tissues around gains the upper hand, organisation sets in, and a dense fibrous capsule is formed, shrinking and becoming harder year by year. In the centre is a little caseous or calcareous mass which may remain quiet for the rest of life, but which is always liable to become the source of future mischief.

Liquefaction may take place. As the caseous centre increases in size, especially if it is near a cutaneous or mucous surface, it gradually becomes more and more liquid, until at length a cavity is formed, filled with a fluid which in external appearance resembles pus, and which used to be taken for it. It is thinner, however, and whiter; caseous masses float about in it, and under the microscope it consists simply of molecular fat, without a definite pus-corpuscle anywhere. Abscesses formed in this way tend slowly to increase in size until at length they approach the surface. Their walls are lined with granulation-tissue, pale, insufficiently supplied with vessels, and containing myriads of tubercle-bacilli, and here and there small caseous masses, softening to add to the fluid. Outside this, and sometimes projecting so as to form septa in the interior, are the larger vessels, sheets of fascia, and dense fibrous structures that resist invasion Growth takes place by the development of tubercles in the walls, following the easiest route, until at length somewhere the subcutaneous cellular tissue is reached. The skin at first separates, unaltered, from the deep fascia, and is lifted up so as to form a soft, fluctuating swelling, perfectly white and natural in texture. After a time, however, it shares the same fate; the bacilli invade it from beneath; tubercles form in its deeper layers; the surface becomes reddened, and at length the abscess breaks, leaving a long sinuous track, winding in all directions from the original starting-point, and lined with a layer of tubercular granulations mixed with caseous *débris*.

Obsolescence may occur even when the skin has been reached, and the abscess extends from the dorsal spine to the thigh; the fluid disappears, the tubercle-bacilli cease to grow, the caseous *débris* becomes more and more inspissated, and at length forms a dense solid mass, which slowly undergoes *cretification*, and remains encapsuled in fibrous tissue for the rest of life. In children this is not uncommon, as tubercular disease of joints is in them distinctly a disease of a certain period.

In other cases, *extension* takes place along the lymphatics. The neighbouring glands enlarge; typical miliary tubercles make their appearance in the interior, forming foci, which, as elsewhere, spread by the margin while they decay in the centre. The capsule, formed of dense fibrous tissue, becomes thickened from the tension, and resists for a great length of time; but at last either it gives way, so that the caseous liquid spreads into the loose cellular tissue round and infects it, or suppuration occurs (peri-adenitis), and when the abscess bursts or is opened, a caseous gland is found lying at the bottom, or adherent to one side, covered over with granulations. Before this, however, the mischief, as a rule, has spread to the neighbouring glands and formed a chain of which it is impossible to find the end.

Finally, *dissemination* may take place through the blood-vessels, and, according to the part of the circulation involved, acute miliary tuberculosis may develop in one, or every, organ in the body. In tuberculous disease of the kidney, for example, it may be limited to the lungs. When this occurs, the constitutional disturbance is generally so severe that the result proves fatal before the tubercles have attained any size or undergone more than incipient degeneration.

Results.—So long as the tuberculosis is local, recovery may be complete, with the exception that the portion of tissue infected is lost, whether it is removed by operation, or undergoes caseation and degeneration with the products of the inflammation. This may take place even when the lymphatic glands are involved. The tuberculous predisposition appears in many cases to be of limited duration. Scrofulous scars are left in the neck; Pott's disease causes permanent deformity, or hip-disease leaves a limb shortened, distorted, and wasted; but as the period of growth ceases, and the lymphatic glands and the ends of the bones lose the functional activity which characterises them in youth, the tubercular process sometimes ceases too, and cicatrices, which remain healthy through the rest of life, are left to show the mischief that has taken place. The tissues round recover sufficiently to throw out vascular granulation-tissue and this becomes organised.

Death may occur either as a direct result of the tubercular process, dissemination taking place and proving fatal from the fever that accompanies it, or from a vital part, such as the brain, being involved; or as an indirect consequence due to the hectic, exhaustion, amyloid disease, &c., that follow on suppuration in connection with caseous foci.

Treatment. 1. *Local.*—Where it is practicable, there is no doubt that the seat of infection should be removed. If this cannot be done, an attempt may be made to check the further progress by the use of germicides, of which perhaps iodoform is the most to be trusted.

On the other hand, when the situation or the extent of the growth precludes this, all that can be done is to place the tissues in the best possible position for dealing with the germs themselves, and protect them from every other injurious influence. Fortunately, age is often of great assistance in this; it seems as if, sometimes, about puberty the susceptibility suddenly ceased, the tissues gained the upper hand, and repair commenced at once.

2. *Constitutional.*—Fresh air, if possible sea air; but an equable temperature, not too moist, and especially free from cold winds. A moderate degree of warmth suits some; a cold dry climate agrees better with others, but no general rules can be laid down for this. A thoroughly nutritious diet, with cod-liver oil, iron, and other tonics, is equally important. Stimulants are not required by the disease, although often they materially assist the digestion. The clothing should be light but warm. A fair amount of exercise should be taken, and, in short, the conditions of existence should be as far as possible, ideal.

SYPHILIS

Syphilis is an infective disease due, in all probability, to the action of a specific organism. Its course, its power of indefinite multiplication in the body, and the fact, not only that it is contagious, but that it can only be propagated by contact, mediate or immediate, are sufficient proof; but it must be remembered that, in spite of the number of those who have tried, no one has yet succeeded in proving the existence of such a thing to the satisfaction of the rest.

In many respects syphilis differs considerably from the specific infective diseases already described. In the first place, although it commences acutely, its course is chronic and persistent. Wherever the inoculation takes place the immediate effect is local; then the lymphatics become involved, and very shortly the poison is distributed through the whole body by the blood-vessels; but after this stage is past it remains in the tissues, either latent altogether, or with very slight evidence of its existence, and perhaps suddenly, after many years, breaks out again. Then it is not only propagated by direct infection to other individuals, but it is hereditary: the poison can be transmitted through the ova and spermatozoa, so that characteristic lesions make their appearance in the child before or shortly after birth; and this transmissibility to the embryo is retained long after the power of infection by direct contact is lost. Further, while other specific germs cause, for the most part, some one definite form of inflammation, which, though it may be modified by locality, is yet characteristic of the cause, syphilis does not limit itself in this way. There is, it is true, a characteristic lesion, but it is also true that there is no form of inflammation which is not imitated, and imitated sometimes so closely that the diagnosis can only be made by the result of treatment. It must be acknowledged therefore that if the microbic origin of the disease is considered proved, there is yet a great deal that requires further elucidation.

The difficulty is not lessened by the fact that syphilis, or at least its initial lesion, is often complicated by the presence of another trouble, known as chancroid, in distinction from the true form of chancre; and it is still, to some extent, a matter of discussion what relation these two bear to each other.

Chancroid or Soft Chancre

A soft chancre, or chancroid, is a sore developed upon the genitals as a result of contagion, and is distinguished from the hard or true chancre partly by the absence of induration, but chiefly (as this is only relative) by the fact that it is seldom or never followed by constitutional symptoms, and that the period of incubation is much shorter: the one is always under a week and generally under three days, the other is always more than three weeks and is often as much as five. The two often occur at the same spot from the same infection, each running its own course independently of the other.

Soft chancre is never met with except upon the genitals, and is probably due to infection from retained and decomposing purulent discharge. The intensely irritating character this possesses may be judged of from the fact that soft chancre occurring on a mucous surface is almost sure to infect the opposite side, and if the secretion is pent up, as in the case of phimosis, is almost certain to become phagedænic. No specific germ has been proved in connection with it. It can be inoculated times without number without conferring the least degree of immunity. It is never followed by any other result than those which are so common after all foul and sloughing sores on parts that are never kept at rest, and constitutional treatment is of little or no avail for it. There is a popular impression that certain people are peculiarly liable to it, which may reasonably be accounted for by local conditions; it does not appear to be dependent upon syphilis, but it may be very closely imitated by a true syphilitic chancre on a person who has already suffered from that disease, and who has not yet passed through the period of immunity that one attack confers. Under these circumstances, if there is a second infection, the character of the primary sore is often very much modified both as regards period of incubation and amount of induration; and although it is a true infecting sore it may present the appearance of an ordinary chancroid. In women, in whom the hardness is often slight and sometimes wanting altogether, the difficulty is especially great.

Symptoms and Cause.—The favourite situation is on the mucous surface of the prepuce, or just behind the corona. A small red papule is the first sign; by the third or fourth day this has become a pustule with a bright areola, and in twenty four hours more it breaks, leaving a sore with angry base and edges. In some few cases this heals without any further ulceration. probably the infection has never really penetrated into the submucous tissue. More frequently it continues to spread, the edges are sharply cut, perhaps undermined; round them is a bright red rim of inflammation; the base is greyish or yellow, covered with a slough; and the whole thickness of the mucous membrane is destroyed. The sore is usually circular in shape and very tender. On the glans it may be perfectly soft, without sign of induration; but when it is upon the skin the base is often infiltrated to such an extent that it is nearly as hard as a true infecting chancre. The margin, however, is different; in a soft sore the edge of the induration is ill-defined; it shades off imperceptibly into the healthy tissues around, and no limit can be made out, but, at the same time, it must be recollected that this is equally true of a hard chancre when it is inflamed; and that, owing to the extreme mobility of the skin upon the penis, any sore with a hardened base felt in the longitudinal direction and lifted up from the tissues beneath, appears exceedingly well-defined. The secretion, at first, is thin and watery, with a few shreds and sloughs detached from the surface floating in it; later, when granulations form, it consists of ordinary pus, such as comes from any other sore.

If, owing to phimosis or balanitis, the secretion is retained under the prepuce, so that it decomposes, the ulceration is very much more severe, and may become phagedænic. The sore increases in all directions; the opposite surface of the prepuce is attacked; the skin on the outside is reddened; the whole of the end of the penis becomes swollen; and if relief is not speedily given, the skin sloughs, ulcerating through from beneath, and the end of the glans protudes through a ragged opening on the dorsum. In the worst cases the destruction is even greater; the whole of the skin covering the end may perish, the glans be in great measure destroyed, and the urethra laid open.

The inguinal glands, that lie parallel to Poupart's ligament, are always more or less inflamed. In the slighter cases they are simply enlarged, swollen, and tender; their outline is indistinct, and if several on the same side are attacked, they cannot be isolated from each other. In the more severe ones suppuration occurs, generally commencing in the loose cellular tissue round (periadenitis), so that when the bubo is opened the glands are seen projecting into the cavity, surrounded and bathed with pus. Sometimes, however, it appears to begin in the interior of the gland, and occasionally in both places at the same time. It is said that when this happens the pus from the interior of the gland is infective, while that from the tissues around is not. Phagedænic and serpiginous buboes are met with exceptionally in very severe cases of syphilis combined with soft sores, or when the patient's health is utterly broken down from want and exposure. No constitutional symptoms ever follow a true soft sore, and the inflammation of the lymphatic glands is merely due to the absorption of pyogenic organisms, assisted by the retention of decomposing secretion or other injurious influences.

Diagnosis.—Herpes preputialis presents the greatest difficulty. This very peculiar affection may occur after every act of connection ; it has even been known to follow nocturnal emissions ; and though it may be more severe and more common in those who have suffered from syphilis, it is certainly met with in those who are perfectly free from the disease. If there is only one vesicle, or two perhaps, and the case is not seen until the epidermis is broken, there is no means of forming a diagnosis.

If, owing to the enlargement and swelling of the prepuce, the existence of a sore is doubtful, circumcision must be performed : and the need for this increases with the amount of redness and inflammation. The coexistence of syphilitic infection cannot be affirmed or excluded until the period of incubation (six weeks at least) is past.

Treatment.—Local chancre spreads because of the poisonous character of its discharge. A single application of the acid nitrate of mercury leaves, as soon as the slough separates, a perfectly healthy granulating surface. So severe a measure as this, however, is rarely necessary unless the sore is phagedænic and it is imperative to stop the progress at once. Ordinarily speaking, if the surface is well cleansed and dried, and then dusted over with iodoform, night and morning, the character of the secretion changes immediately. Phagedæna should be treated, as already mentioned, by the use of prolonged warm baths. Mercury is not required unless the healing of the chancre is unaccountably delayed, or there is something else suggestive of syphilis.

ACQUIRED SYPHILIS

The period of incubation varies from three to seven weeks : at the end of that time certain local changes make their appearance (the hard or infecting chancre) ; a few days later the lymphatics are involved, and then very quickly there is evidence that the poison has gained access to the blood. Much later, after an interval of months or years, local phenomena appear again, due in all probability to the action of the poison latent in the tissues. These stages, of course, overlap each other, and no hard and fast line can be drawn between them ; thus the lymphatic tissues and the blood are always involved before the chancre has disappeared (indeed there is evidence to show that they are affected almost from the first, although there is no manifestation of it for some time, for excision of the point of inoculation after the third or fourth day is of little or no use) and local changes may take place while the general ones are still at their height ; but the distinction between the three is convenient, and they are recognised as primary (or local), secondary (in which the lymphatic glands and the blood are involved) and tertiary, or local again.

1. The Primary symptoms.—Inoculation may take place anywhere through a wound or superficial abrasion, or possibly in the case of mucous membranes even without this, if the poison is allowed to remain upon the surface for any length of time. The retropreputial fold is the commonest situation in men, the nymphæ in women ; but chancres are met with upon the skin of the penis, upon any part of the female genitals, and practically on every part of the body : the lips not uncommonly ; the tongue and even the tonsils ; the conjunctiva ; the bridge of the nose ; the nipple (especially in wet nurses who are infected by children suffering from hereditary syphilis); the angle of the finger-nails, and the web of the fingers.

In a pure inoculation no change is witnessed for from three to six weeks; a transient redness has been described during the first few days, but it is not often noticed. Then the part becomes dusky, slightly elevated, smooth and glazed. In the ordinary situations it is not sensitive, and the patient may be in total ignorance of its existence, but I have known some instances in which the pain was very severe, especially when it occurred upon the fingers. The characteristic feature is the induration; the seat of inoculation is not only hard, but the edges of the hardness are sharply defined. If pinched up, it appears like a piece of cartilage let into the skin. The exudation in the meshes of the cellular tissue is so abundant that a certain small but well-defined area becomes practically solid.

It must be admitted, however, that this induration varies so greatly in different localities and under different conditions, that, although its presence when it is characteristic may be absolutely relied upon, its absence is not a proof of non-infection. On the glans, where the mucous membrane is thin and closely adherent to the tissues beneath, it is very superficial. In the retro-preputial fold it is often so marked that the diagnosis can be made from merely seeing the way in which the hardened and thickened prepuce rolls back from the sulcus, and stands up like a collar round it. In women it is often not to be discovered at all, and when the chancre occurs on other parts of the body—the lips or fingers, for example—it varies within very wide limits. No doubt this is due in some measure to the anatomy of the part inoculated—the presence, for instance, of loose cellular-tissue beneath—and the depth to which the inoculation is carried in each case; but the extent and duration are so variable that there must be other considerations as well. There is no relation of any kind between the size, hardness, or number of the infecting sores and the severity of the constitutional symptoms. Several sores may be present at the same time from multiple inoculation, but the worst cases often follow a single one that is scarcely noticed.

The appearance of a hard chancre is very variable; the skin that covers it may remain unbroken, so that there is neither secretion nor ulcer, but merely a slightly raised and hardened spot, pigmented for a time. This, however, is exceptional. More frequently the epidermis scales off, exposing the subjacent tissue, which undergoes necrosis and melts away; but whether this is due to the effect of the poison, or simply to pressure, is not known. When this happens it leaves a superficial sore, which may or may not suppurate; in many cases the only discharge is a thin watery serum with a few epithelial scales, or a little tissue-débris without true pus from first to last. If a soft chancre is present already, the appearance and the discharge are naturally dependent upon this; the only change at the end of the incubation period is a sudden hardening at the base. Chancres in the finger usually take the form of a patch of small and rather florid granulations, with little discharge, and without any evidence of cicatrisation at the edge. The margin is raised above the level of the skin, and appears steep and thick from the exudation it contains. On the lips it is much the same, only in some cases the infiltration at the base and edges is so great that it is slightly cup-shaped.

The duration of the hardening and rapidity of cicatrisation are no less 'ariable. If untreated, the sore is said to last six or nine months, and leave cicatrix depressed according to the amount of tissue lost. Very often, iowever, under the influence of mercury it vanishes altogether in a few veeks, and it is exceptional for it to continue more than three months. Its lisappearance is not complete until all hardness is gone from the cicatrix; ometimes, when a hard sore complicates a soft one, healing takes place very oon after commencing mercurial treatment, but in spite of this, the induraion of the base persists for a considerable period.

When the infection is mixed, the extent of the suppuration is sometimes rofuse, but there is no evidence that it is ever sufficient to prevent the levelopment of constitutional symptoms. The same may be said of phagelæna. Relapsing chancres are occasionally met with. It is not uncommon o find, if the treatment is interrupted too soon, that the induration, which vas beginning to subside, extends again; but, independently of this, true elapses occur, sometimes a year afterwards, the seat of the original inection becoming indurated again, and slowly subsiding under treatment vithout there having been a sign of its existence in the meanwhile; and his may happen more than once.

2. **The Secondary symptoms.**—The secondary stage includes the inection of the lymphatic glands, and the general symptoms that follow the ntry of the poison into the circulation.

Glandular enlargement usually shows itself ten days or a fortnight after he appearance of the primary sore. The local ones are affected first, the nguinal, for example, when the chancre is on the penis, the submaxillary vhen it is on the lip; but it never remains limited to them. From the beginning the enlargement is multiple, and it soon becomes general, not as in he case of the uncomplicated soft chancre, limited to one locality and often o one gland. The character of the swelling is also quite different. Unless he infecting chancre is inflamed, or a soft one is present as well, there is ittle or no infiltration of the periglandular tissue; the enlargement is confined to the glands themselves; they swell up, become hard, and slightly tender, but they remain perfectly isolated and distinct, and they are as freely movable as they are in health. The inflammation is specific, not simply lue to absorption of septic or suppurative products.

Whether suppuration occurs in the first set of glands involved depends ntirely upon the character of the sore; if it is foul and sloughing, the pyogenic organisms will, in all probability, gain access through the lymphatics, nd finding a congenial soil, excite suppuration, whether syphilis is present or not, and without having any influence upon it. The same thing is rue of phagedæna; an ulcer left by a suppurating bubo, occasionally under he combined effect of syphilis, a broken-down constitution and other injurious nfluences, becomes itself phagedænic; but at the present day it is decidedly rare. The glands once removed, too far distant to be affected by local causes of this character, sometimes attain a very considerable size, but never form abscesses. As a rule the enlargement subsides quickly at first, but evidence of it can usually be found so long as the secondary period lasts and sometimes long afterwards.

As soon as the poison gains full access to the blood, it causes a train of symptoms which may be compared with those that accompany the acute exanthemata and other specific diseases.

There is a slight but fairly constant degree of *fever*. The temperature rises regularly of an evening, although of a morning it may scarcely be above normal. In exceptional cases it is very severe, especially when the eruption that accompanies it is varioloid, or there is considerable glandular enlargement, and it may last for several weeks.

Anæmia and emaciation are always present, and sometimes very marked. The number of red blood-corpuscles is diminished, and, it is said, the proportion of hæmoglobin they contain. With this there is usually general *malaise*; the appetite is lost, there is great mental depression, and, in short, there are all the signs of mild blood-poisoning.

At the same time, or even before this, a *rash* makes its appearance upon the skin and the mucous membranes. This varies very greatly in its character and severity. In the mildest cases there are merely a few round roseolous spots upon the chest, abdomen, and flexor surfaces of the arms, lasting some days, then dying away with a scarcely perceptible scurfiness of the integument, and leaving a faint yellow stain for a week or two. More frequently in addition to the hyperæmia there is a certain amount of exudation; the roseola spots are raised, and followed by definite desquamation, or little papules and tubercles are formed. When the attack is more severe the inflammatory changes may be very considerable, and stasis and actual extravasation take place as well, so that deep stains are left for months. The eruption sometimes resembles psoriasis, although the distribution is not the same and the patches are always small, and not covered with silvery scales; it frequently imitates lichen, and, especially on the shoulders and back of the neck, acne; in some cases it resembles variola so closely, that patients suffering from syphilis, every now and then, find their way to small-pox hospitals, particularly as this form is often accompanied by high fever; and, towards the end, when the first eruption is dying out, rupia sometimes occurs, a number of papules running together, ulcerating, and forming on the surface a great conical limpet-shaped crust of dried-up discharge, which keeps enlarging in height and circumference, just like a shell, by addition to the margin as the destruction spreads.

Where the skin is moist, and in contact with another surface, these spots are modified into mucous patches or flat *condylomata*. The epidermis is macerated away; the papillæ, already inflamed, are exposed and irritated more and more, and at length raised patches are formed, something like a mucous surface (whence the name), moist, pinkish-red, and smooth. They are met with in every part, but the favourite places are between the nates, inside the labia, under the penis between it and the scrotum, in the axillæ and behind the ears.

The mucous membranes are similarly affected. The interior of the mouth, the tongue, the soft palate, and the larynx are covered with an eruption identical with that upon the skin. The epithelium is bluish-white from maceration; round this is a bright red rim, gradually fading away; and in the centre there is often a small superficial abrasion. On the tonsil this gives the appearance of a deeply punched-out ulcer; on the soft palate it usually occurs just at the margin on each side of the uvula, the rest of the surface being a dusky brownish-red; and on the tongue it forms a smooth bald patch. Sometimes, when the eruption is papular, raised mucous plaques are produced instead.

At the angles of the mouth, nose, and anus, and in the clefts between the toes, the eruption assumes a slightly different form. It is just as if a mucous patch had formed in the angle of junction, red, moist, and, differing in this respect from those that occur elsewhere, intensely painful. This, of course, is due to their situation.

In the lighter forms of eruption there is merely hyperæmia with scarcely any exudation. In those that are a little more severe there is enough to cause desquamation, the epidermis either drying up in scales or becoming macerated, according to its situation. When the amount of exudation is considerable, stasis and perhaps extravasation occur (as in the tubercular syphilides); some of the tissues perish, and a deep brown, depressed stain is left, with an altered appearance of the surface, owing to the regularity of the papillæ having been destroyed. In the worst cases, when pyogenic organisms as well gain access to the part, as in rupia and phagedæna, the loss of tissue may be very extensive, causing cicatrices that cannot be mistaken. The intensity of the poison, the constitution of the patient, the anatomy of the part, and the conditions under which it is placed, all take a share in the result.

The characteristic features of a secondary syphilitic eruption are its *symmetry* (this is often perfect, spot for spot, both in time and place), its *colour* (usually described as resembling that of lean ham and in most cases leaving stains behind it), and especially its *polymorphism*. True psoriasis is psoriasis wherever it occurs, and, except perhaps in the direction of lichen, never really resembles anything else. Lupus acts in the same way, and so with variola and other specific affections. Syphilis, on the other hand, may, and usually does, present a fairly good imitation of half a dozen of these at once. Where the skin is thin, as on the chest and arms, there are roseolous spots; a scaly eruption is more frequent where it is thicker; papules are common round the roots of the hair; acne spots may be found on the shoulders; little dark coloured tubercles occur upon the legs; one or two rupia spots may be present at the same time, and not unfrequently the ala of the nose is rapidly destroyed by a phagedænic imitation of lupus. All these are often present together, or, what happens still more frequently, the milder varieties come out first, generally all over the body; many of the spots disappear, leaving stains behind them; others steadily get worse, the amount of exudation continuing to increase, and then they become complicated by suppuration. So that in this way tubercular syphilides, the varioloid form, and rupia, are scattered among psoriasis patches, acne spots, and the stains of past roseola. The pigmentation after secondary syphilis is suggestive, but nothing more, as deep stains are not unfrequently left by true psoriasis, especially upon the legs and back. The most characteristic is that which is associated with rupia scars, where there is a dead white tissue-paper cicatrix in the middle, and round it an irregular circle, often deeply stained.

Recurrent attacks of roseola are not at all uncommon, sometimes occurring with recurrent hardening of the primary sore. It does not follow either that the same part of the body is involved (it may be present on the hands in one attack and not in the other, for example), or that the eruption presents the same character.

The skin eruption, the anæmia, and the fever are very rarely absent, supposing secondary symptoms of any kind are present. In addition to these there are other lesions which are frequent, but by no means universal, and which, though to a certain extent symmetrical (showing thereby their dependence upon the condition of the blood) are still distinctly local, and constitute, as it were, a transition to those later forms (tertiaries) in which the tissues only are concerned.

Periostitis, especially of the superficial portions of the compact bones (e.g., the tibia, ulna, clavicle, and cranium) is one of the most common. It is always acute, very painful, and subsides readily under treatment, without leaving any thickening. Vague so-called rheumatic or *osteocopic pains*, occurring in the bones at night, are probably due to transient hyperæmia without exudation ; and in some of the cases in which there is severe localised headache it is possible there is a similar affection of the dura mater.

Synovitis may occur, both in the tendon sheaths and joints, but it is more rare. *Alopecia* is not infrequent, the hair of the scalp often falling out in tufts, so that the appearance is most peculiar. It is never permanent. *Epididymitis* (as distinguished from the orchitis of later syphilis, in which the epididymis is often involved) is occasionally met with. Recently I have seen two cases of secondary syphilitic *phlebitis*, in one of which, among other veins, some of those in the internal ear were affected, deafness with many of the symptoms of Menière's disease coming on quite suddenly. *Arteritis* is more common later on.

In other cases there is a great tendency to the production of papillomatous growths almost unattended with inflammation. These are known as *verrucæ or pointed condylomata* ; they may form great dendritic masses when they grow from the genitals, or be merely simple papillæ somewhat enlarged, like those that are so frequently met with upon the dorsum of the tongue, far back in the middle line. No distinction can be drawn between them and the ordinary flat mucous patch with which they are often associated.

Finally, although the two eyes are rarely affected symmetrically in point of time, iritis must be placed among the occasional secondary symptoms. Later affections of the eye, choroiditis, for example, and neuroretinitis, are sometimes included as well.

Duration of the Secondary period.—No definite limit can be assigned ; there may be no symptoms at all ; it may last a month, or it may be continued for a couple of years.

The symptoms are for the most part symmetrical, the earlier ones always so, because in all probability they are due to the effect of the virus upon the blood itself. Long before these have passed away, however, the tissues are involved as well, and then asymmetrical lesions are mingled with the others ; later still, when the blood infection has quite died out, in the so-called tertiary stage, these occur alone.

Secondary symptoms have a tendency to get well of themselves ; the blood and the tissues may yield at first to the effect of the poison, but provided the patient is in fairly good health, and not exposed to influences of a too injurious character, the lesions subside again, even without treatment. Later in the tertiary period the tissues seem to lose this power and the morbid changes steadily grow worse and worse.

The blood and the discharges from the eruptions are inoculable during the secondary period. There is no authenticated case of the disease having been transmitted in this way from any tertiary affection. How long the power of infection by contact lasts is naturally uncertain ; it may be a few months, but it is rarely more than two years. This disappearance from the blood is not due to any alteration in the blood itself—to the exhaustion, for example, of some substance necessary for the growth of the poison—for second attacks of syphilis are by no means uncommon ; and it sometimes happens that a person becomes affected for the second time, and that the disease runs a scarcely modified course while tertiary symptoms are actually present. It is no less true that the virus remains the same, and is capable of regaining its vigour if the conditions are a little changed. Direct transmission to another individual may no longer be possible ; but the ovum can be infected through the spermatozoa long after the secondary symptoms have subsided, and shortly after birth the child may become covered with an eruption of an intensely contagious character. Transplanted in this way to a fresh soil, the virus regains its vigour and multiplies again indefinitely, the period of incubation, before it manifests its influence, depending very largely upon the activity of the poison in the parent. The more recent the infection in the latter, the shorter the incubation in the embryo, and the more disastrous the results. It would seem, therefore, that the virus, when it leaves the blood and becomes embedded in the tissues, may either remain latent for years (perhaps for life) ; or may at any time cause local inflammation of a progressive character, slowly infecting the structures around—tertiary symptoms ; but that except under certain conditions (of which transmission to the embryo through the ova or spermatozoa is one), it has lost its power of inoculation.

Suppuration, like phagedæna, is an accident in syphilis which may occur in connection with secondary as well as tertiary lesions. That it is not seen more frequently in the former is probably due to their transient character, and the small amount of exudation that accompanies them. Many of the slighter forms of secondary syphilitic affections, whether they involve the skin, the periosteum, or the iris, are probably merely attended with hyperæmia ; in the more severe ones, however, especially those that occur rather later, the amount is often considerable ; and then, especially if the lesion is near the skin or a mucous surface, suppuration and ulceration are very likely to follow. A syphilitic affection is not tertiary, because it leaves a scar. Rupia, which distinctly belongs to the late secondary manifestations, leaves perfectly typical cicatrices, which can be recognised throughout the rest of life, dead-white, circular, with a rim of pigment interrupted here and there, and as thin as tissue paper, wrinkling like it when pressed together. The only condition that can be mistaken for it is the scarring left by splashes of molten metal.

Tertiary Syphilis

The tertiary period does not admit of exact definition any more than the others. It may begin within a few months of the primary infection, while the secondary symptoms are still present, or it may be postponed for years. There may be a period of complete immunity during which the patient shows no sign of disease, or one form of lesion may succeed another without a break.

For convenience' sake an intermediate stage is sometimes spoken of, during which the patient is subject to certain affections known as 'reminders,' iritis for example, choroiditis, orchitis, arteritis, and scaly eruptions upon the hands and feet ; these are distinguished from the true secondary forms, upon the one hand, by their want of perfect symmetry, and from the tertiaries, upon the other, by their tendency to get well, more or less, of themselves : but the definition of these stages becomes difficult in proportion to their multiplication.

The history of acquired syphilis is a continuous one, although sometimes there are long breaks in it. At first the virus infects the tissues around, producing a hard chancre. Then it gains the lymphatics and involves the blood; during this stage it is inoculable, the lesions are symmetrical and tend to get well of themselves. Long before this has passed it has begun to affect the tissues too, at first simply leading to a transient hyperæmia: then, as the power of their resistance diminishes, causing a certain degree of exudation; and finally in the last stage (which when the vitality of the tissues is very low may begin almost at once) forming great masses of inflammatory granulation-tissue which slowly undergo caseation. There is no break anywhere in the pathological changes; they shade off imperceptibly one into the other; the distinctions are that, while the virus affects the blood it is inoculable, when it involves the tissues only it is not, though it may regain its power under peculiar conditions; and that after it has spread from the blood to the tissues, these lose the power of dealing with it unaided, so that the lesions continue to grow worse.

The histological changes in tertiary syphilis are identical with those that occur in the other forms of chronic infective inflammation; the difference is in their distribution and course. Wherever the virus spreads it lowers the vitality of the tissues with which it comes in contact, or kills them; and at once those around begin to throw out granulation-tissue composed of leucocytes with epithelioid and giant cells (a few only) as in tubercle, and the other infective granulomata. The ultimate fate of the exudation and the effect it produces in different parts of the body depend upon its situation and amount. In some places it undergoes organisation, becoming converted into dense fibrous tissue, or bone, as the case may be. This is most common where it is scattered throughout an organ, not collected in one spot, and is often partial, some being absorbed. In a measure, it may be regarded as a process of repair, but it often leads to the most disastrous consequences from the condensation it entails. In others, in which instead of being uniformly distributed it is collected into masses, caseation sets in as soon as they attain any size. Whether this degeneration arises from the effect of the virus upon the lymph (as in tubercle), or is due to the arteries being blocked by the thickening of their intima, is not known; in any case the change is not one peculiar to tubercle or syphilis. Masses of this kind are known as *gummata.* When first formed they consist merely of soft vascular granulation-tissue, and so long as they are spreading the margin retains this character. As they increase in size—and they may reach that of a walnut or be larger still—a certain degree of organisation sets in; and then, following this, caseation. Three strata, therefore, can be distinguished: outside a layer of still growing inflammatory exudation, spreading in the direction of least resistance, and therefore very irregular in shape; inside this, partial organisation, and in the centre, a caseous mass. Naturally the relative proportion of these three is very variable; in many cases the second is hardly perceptible.

In addition the lesions of tertiary syphilis are frequently complicated by suppuration. The pyogenic organisms, which are practically of general distribution, although they are unable to produce any effect so long as the tissues are healthy, live and thrive when there is disease, and hasten the process of destruction.

If they gain access to a deeply-buried caseous mass (in the tongue for example, or the subcutaneous tissue) not unfrequently the whole of the infiltrated part perishes, becoming gangrenous from the intensity of the combined effect; the skin or the mucous membrane, as the case may be, gives way; a circular opening is left, with undermined and steeply-cut edges, and at the bottom is a yellow, wash-leather-like slough. Similarly, if the infiltration is in the substance of the skin, various forms of ulceration follow. It is this mixture of organisation and caseation, suppuration and sloughing, while all the while the syphilitic inflammatory exudation is continuing to spread at the margin, that causes the immense variety of the lesions characteristic of the tertiary period.

Intermediate symptoms.—The symptoms of the secondary stage are acute, and tend to get well. After they have subsided there is often a period of complete immunity; but in many cases, if inquiry is made, it will be found that after all the symptoms that are really secondary have disappeared, there have been local attacks, somewhat the same in character, but more chronic in their course and much less severe. Their distribution is not general, and they do not occur indiscriminately, only where there is some other source of irritation; there is a greater amount of exudation than in most of the secondary symptoms, and though they occasionally get well of themselves, there is, on the whole, a decided tendency for them to spread. In other words, they form a transition to the true tertiary ones.

The eruption that occurs on the palms of the hands and the soles of the feet is an example. In the secondary stage a number of separate spots form rapidly, become scaly, and disappear again in a week or two. Later, if they recur (and naturally this is more common on the right side than the left), their course is more slow, they are fewer in number, there is a greater amount of exudation, the scales are less distinct, and they have a tendency to spread at the margins. In the true tertiary period, if an eruption breaks out in this locality, it is raised, almost tubercular, very chronic, and extends in widening circles or parts of circles. In the centre, at the spot where it began, it gradually dies away, leaving a smooth, more or less shiny and pigmented surface; there is no distinct cicatrix, merely an alteration in the texture of the skin; at the margins it steadily advances, and if at any time one spot becomes isolated—if, for example, the whole of it is cured but in one little place—this forms the focus for a fresh ring.

The same thing occurs at the angles of the mouth and nose, and to a less extent at the anus. The eruption returns again and again, leaving painful cracks and fissures, lined with a smooth, raw, readily-bleeding surface. They are not unlike the sores that occur at an earlier period in the same locality, but are more chronic; there is a greater amount of thickening at the base; they tend to spread in circles, or parts of circles, on to the chin and lips, and they leave white linear cicatrices when they heal.

The tongue shows the same, especially with smokers. White patches return again and again, until, at length, all the papillæ are levelled up by the exudation, and a smooth, bare, white spot is left, surrounded by a still extending infiltration. In other parts of the body there are circular cutaneous eruptions, or patches closely resembling the lighter forms of lupus, especially those that scarcely leave a scar; or sometimes affections of a still more serious character, iritis, arteritis, orchitis, periostitis, &c.

In many cases, especially when treatment is thoroughly carried out, these, year by year, grow milder and milder, until at length they cease altogether. On the other hand, it sometimes happens that, after a variable and most deceptive period of quiescence, true tertiary affections follow, steadily progressive in their character, and inevitably, if not thoroughly treated, passing on from bad to worse.

Tertiary symptoms.—Two chief varieties can be distinguished, although it is impossible to draw a definite line between them. The one is characterised by, at first, an enormous local collection of inflammatory deposit—a gumma, which, according to the conditions under which it is placed, undergoes caseation, absorption, or sloughing. The other, which is not so striking, leads at once to organisation and condensation without any preliminary stage.

The skin.—Nodular and tubercular eruptions of various degrees of severity are common upon the back of the neck and shoulders, round the scalp, and in the region of the nose and lips. In the last-mentioned locality they often resemble lupus very closely, but the little elevations have not the gelatinous appearance characteristic of true lupus, the course is more rapid, and if there is a cicatrix it is firm and white, not thin and red. Moreover, it rarely happens that all the spots present the same characters. The milder forms subside without leaving any definite mark other than pigmentation; those that are more severe, in which the amount of exudation is greater and the natural texture to some extent absorbed, cause a peculiar flattened and smoothed appearance of the skin; the worst, in which suppuration occurs as well (this is especially common upon the legs), leave definite cicatrices that vary in depth according to the amount of the deposit. Wherever the eruption occurs, it is always serpiginous, healing in the centre, constantly creeping on at the margin, so as to form rings or parts of rings, often intersecting, as when one has advanced in one direction and crossed another, and the cicatrices naturally follow the same course. It is common to find a pigmented spot from which the eruption started; then, a thin cicatrix, scarcely producing a definite alteration in the skin; beyond this, typical scar-tissue, white, with patches of dark pigment here and there, and on the extreme margin a ring of ulcers and nodules; the eruption starts in the centre, and gradually increases in depth and width the longer it lasts.

The cellular tissue.—The subcutaneous and submucous tissues are especially liable to be the seat of gummata. A smooth, rounded swelling forms rather rapidly and without much pain, the skin over it becomes red and adherent, then it gives way, retracts as only skin can retract when it is separated from its deep attachments, and leaves a deep, circular, punched-out hole, with perhaps at the bottom a slough formed from the cellular tissue. Round the knee-joint is a very favourite locality, and, combined with the skin eruption, of which they are merely a deeper variety, these gummata lead to characteristic cicatrisation. Not unfrequently they extend some distance down the leg; and it has been said, with as much truth as is usual in universal statements, that every ulcer that begins between the middle of the leg and the knee is due to syphilis. Other joints are not so often attacked; but wherever there are bursæ, gummata and serpiginous eruptions upon the skin are always liable to occur, partly because of the amount of loose cellular tissue, partly from the way in which structures of this kind are exposed to injury. Submucous gummata are of common occurrence in the tongue, soft palate, and pharynx, and possibly some cases of stenosis of the trachea, œsophagus, and rectum originate in this way.

In addition to these localities, gummata may occur in any of the soft tissues; in the synovial and peri-synovial tissues of joints, simulating strumous disease; in the membranes of the brain and spinal cord, causing epilepsy, convulsions, paralysis (especially of the oculo-motor nerves), and paraplegia; in the walls of the arteries, leading to aneurysm, thrombosis, and even rupture; in all the viscera, but especially the testes, liver, and lungs, and particularly in the substance of the muscles. Wherever they form they give rise to rapidly-growing swellings, attended with a considerable degree of inflammation, and affecting all the structures around. Suppuration is chiefly liable to occur in the superficial ones, and those that are exposed to injury.

The effect produced by gummatous infiltration of the tissues does not disappear with its absorption. Not only is there at the time a certain amount of actual destruction which can never be repaired, but even when all the syphilitic exudation is removed without there having been a trace of pus, a dense, hard, and contracting cicatrix is left, which in certain situations leads to very serious results. A typical example of this occurs in the liver, in the middle of which it is not uncommon to find a deep star-like mass of cicatricial tissue, radiating in all directions; and even worse consequences may follow when, for example, the dura mater is involved, or a stricture is developed in the trachea or œsophagus.

The bones and the periosteum.—In the secondary stage, when the symptoms are acute the vascular layer of the periosteum is the part chiefly affected; if the attack is slight there is merely hyperæmia; when more severe, exudation takes place as well, stretching the fibrous layer and forming an intensely painful node, generally on the subcutaneous surface of one of the long bones; in the tertiary stage, when the disease is chronic, the bone itself is the part involved. In this syphilis merely follows the ordinary rule; acute inflammation cannot occur in compact bone; time is needed for the necessary histological changes, the softening and absorption of the solid parts and the expansion of the Haversian systems.

The vault of the skull is one of the favourite situations. A swelling slowly forms under the scalp and gradually increases until at length the soft tissues over it become inflamed from the tension to which they are subjected. It is painful, especially at night, but not in the same way as a secondary node; and it is very tender on pressure. Then it breaks down, suppuration follows, the skin gives way, and the bone beneath is exposed, rough, carious, and often blackened already. The syphilitic exudation penetrates into all the Haversian canals, eats away their walls until the bone becomes porous, and then undergoes caseation, the bony trabeculæ still left perishing at the same time from their blood-supply being cut off. Even without suppuration extensive areas on the vault of the skull may be destroyed in this way. If pyogenic organisms gain access too, the inflammation is much more severe; necrosis occurs as well; and huge plates, involving the whole thickness, may perish from the frontal or parietal bones, leaving the dura mater exposed beneath. Typical, deeply depressed cicatrices in the frontal region, are sometimes seen, caused in this way; and the pulsation of the brain can be felt through them, for no new bone is ever formed.

Similar changes are met with in connection with other bones. Gummata of the hard palate are exceedingly common, leading to perforation, always in the middle line. Sometimes they are limited to the mouth; more frequently they involve the septum, turbinate bones, and even the nasal ones, so that a huge cavity is left filled with necrosed fragments and decomposing pus, and shut off almost altogether from the pharynx by the adhesion of the soft palate to the posterior wall. In the neighbourhood of joints it leads to still greater destruction ; every part of the articulation may be affected, the skin may be reddened, infiltrated, and covered with ulcers ; the subcutaneous and perisynovial tissues filled with exudation ; and the ends of the bones and the periosteum swollen, softened, and eaten away to such an extent that recovery seems almost hopeless. Sometimes gummata form in the medullary canal of one of the long bones, leading to so-called spontaneous fracture. More frequently, especially in the case of the lower extremity, the exudation is, in part at least, diffuse, and dense hard masses of new bone are formed : or the two are combined, ulceration and necrosis occurring in one spot, and hypertrophy over the rest. Symmetrical osseous nodes of immense size are not infrequent on the inner surface of the frontal bone ; but, although the diploe may completely disappear, they rarely extend beyond the mid-parietal region, and are never seen upon the outside.

The cartilages of the larynx, especially the epiglottis, are frequently attacked. In some cases, the ulceration begins on the surface and extends into the deeper structures ; in others, a gumma forms on or round them in connection with the perichondrium ; suppuration sets in, and when the mucous membrane gives way the cartilage is laid bare, dead and already partially separated. Very serious stenosis of the larynx may be caused by the cicatrisation that results. Similar changes are of common occurrence upon the costal cartilages, and even more frequent upon the sternum.

Tertiary syphilis when it affects the *nervous system* does not so often give rise to the formation of gummata (although these may occur in the membranes round the brain and spinal cord and lead to very serious changes) as to a peculiar form of sclerosis, which tends to spread indefinitely. It is probable that it is always preceded by effusion, but this rarely attracts attention before the consequent atrophy has begun ; wherever it occurs it is characterised by a steady tendency to progress and invade the structures round, as surely as a serpiginous eruption in the skin, or a neglected gumma in a muscle. Unfortunately it does not respond so easily to treatment.

The symptoms to which it gives rise naturally present the greatest possible variety. The cranial nerves may be involved, especially those connected with the eye. Amaurosis may occur from atrophy of the optic nerve ; ophthalmoplegia externa from paralysis of one or more of the nerves that control the movements ; or this may be combined with paralysis of accommodation as well, so that the pupil is dilated, the eyelid dropped, and the eyeball fixed, according to the nerves involved. The fifth and the facial suffer sometimes as well. General paralysis may follow from the same cause ; probably locomotor ataxy with its multitude of complications is often occasioned by it ; epilepsy and insanity certainly are, and, in short, there is scarcely a trouble due to chronic inflammation of the brain or spinal cord, or the nerves issuing from them, that cannot sometimes be traced back to the influence of the syphilitic virus. That affections of this kind are always due to syphilis is another matter altogether ; when they are steadily progressive it is very probable they are, the virus slowly but surely extending its field in the nervous system as upon the skin ; but it is only one of the causes, even if it is the commonest; and the particular locality and the special kind of lesion are probably always determined by other predisposing agencies. Unhappily, although, if treatment is commenced in time, the progress of the disease may generally be checked, its effects when it has once declared itself are permanent.

Prognosis.—Syphilis, even if it is not treated, gradually tends to die out in the majority of cases; out of ninety-three watched by Diday, only four suffered from early tertiary symptoms, though twenty-nine had eruptions of various kinds, periostitis, iritis, and other severe secondary affections for upwards of two years. At the present day, however, the course of the disease is always so modified by treatment that such observations are of little value. Like measles, small-pox, and other specific diseases, it is said that, when carried to a fresh country, it becomes intensely virulent. On the other hand, in other parts of the world, in Iceland for example, serious effects are seldom seen. Very much must depend upon the constitution of the individual; cases are sometimes met with in which, in spite of everything that can be done, the disease steadily progresses from bad to worse, the most disastrous tertiary symptoms making their appearance early in its course. As a rule, in these there is a history of long-continued intemperance, or of Bright's disease; and very often the patient is already past middle life; but they are occasionally met with in the young, and in those who are in good circumstances. As might be supposed, if there is any tendency to phthisis the prognosis is distinctly more grave, pulmonary symptoms not infrequently making their appearance during the cachexia of the secondary stage, and running a rapid course. Syphilis is rarely directly fatal, unless the cerebral arteries are affected.

In the vast majority of cases, if treatment is commenced at once, and carried out thoroughly, and if the patient can and will give up a sufficient length of time to it, secondary symptoms are either avoided altogether, or occur in a very mild form. It is, however, of the utmost importance to begin at once, as soon as there is a suspicion of the disease; if the poison is once allowed to gain a settlement in the tissues, if, that is to say, local symptoms (other than the primary chancre) have made their appearance, the prospect of permanent cure becomes much more doubtful. The reputation enjoyed by some of the foreign bath resorts is due partly to the change in living, but chiefly to the fact that the treatment of the disease is made the first consideration there, everything else being subordinated to it.

One attack confers only a limited degree of immunity. Auto-inoculation from a primary chancre merely leads to the formation of a papule, unless the sore is inflamed or suppurating. After the secondary period has subsided, a fresh infection generally causes the development of a modified chancre, which is not followed by any further symptoms; but this rule is by no means invariable. I have known several instances in which second attacks of syphilis have occurred within three years, and more than one in which local cutaneous eruptions were present at the time of the second infection. In some of the cases the second attack was milder than the first; in others, it appeared to be entirely uninfluenced by it, running a typical course; in one it was distinctly much more severe, and was followed by tertiaries.

During the primary and secondary stages, the blood and the secretions from the eruptions (especially condylomata) are intensely infective, and the greatest care is required to prevent mediate contagion: many cases have arisen from smoking a pipe that has been used by a syphilitic person. The normal secretions, however, seem to be free from it. In the tertiary stage, the virulence appears to die out, so far as direct inoculation is concerned.

With regard to *hereditary transmission* the facts are not so clear, and a distinction must be drawn between the likelihood of infection and the severity of the symptoms. It is well known that of twins the one may suffer severely, the other hardly at all; and it is said that one may escape altogether.

Where the treatment of the parents is neglected altogether, or what is nearly equally bad, merely carried out in a casual way from time to time, the ordinary rule is for the earlier children to suffer, the later ones to remain free. Not infrequently, however, owing perhaps to the fact that the infected parent is taking mercury at the time, one or more of the children in the series escape. Sometimes the last-born is affected after a long interval of freedom, the strength of the mother failing from age, or from frequently repeated pregnancies, and the child suffering in consequence.

It is generally held also—but the evidence upon this point is much less satisfactory—that not only do the chances of escape increase, but that the disease itself becomes milder as the date of parental infection becomes more distant; and certainly it is not uncommon to find a long series of miscarriages, then a child born alive, but dying shortly after birth, and then several, one after the other, each apparently less affected than the one before. Against this, on the other hand, is the fact that syphilis, under whatever circumstances it occurs, is the same disease. It varies, beyond all doubt, immensely in different individuals, but there is no proof that such a thing as a mild inoculation or a stronger one is possible. If a child is infected through one of its parents, it may suffer from a slight attack or from a severe one, but this does not depend upon the inoculation or the date of infection in the parents, but upon the child. Early miscarriages may very probably be accounted for by local affections of the uterus or placenta, the slighter severity in the later children by the improvement in the general health of the parents, and the occasional intensity in one of the last-born by the failing power of the mother, and the consequent feeble development and nutrition of the child.

The child may be affected either through the father or the mother or through both. It is generally believed that when the mother is diseased the child suffers more severely, and, no doubt, death of the fœtus before birth is commonly due to some affection of the uterus or placenta, but, except upon this point, there is no direct evidence one way or the other. The ordinary infection is through the father; the mother may show no sign of the disease, but, as was first pointed out by Colles, it is impossible to believe that she escapes. An infected child is almost certain to transmit the disease to a wet-nurse, never to its own mother.

If the father's attack is recent, the disease is communicated directly to the mother and the fœtus is exceedingly likely to die in utero from some local lesion. If the secondary stage (and with it the period of direct inoculability) is past, the ovum may, or may not, be rendered syphilitic by the spermatozoa. The only explanation of the fact that the mother is not infected by the child after birth, is that she has been already rendered syphilitic through the medium of the fœtus before birth. When this occurs, the mother does not suffer from secondary symptoms: the poison, beyond all doubt, is modified by the conditions under which it is acting (the length of the incubation period in the embryo is proof), and transmitted in this way does not appear to cause them; but tertiary lesions may follow later, for it is not uncommon to meet with them in women in whom the most careful inquiry fails to reveal any evidence of secondaries.

The child, there is no doubt, may become infected through the mother alone. If syphilis is acquired during the earlier part of pregnancy, the fœtus is affected and suffers from the ordinary effects of the congenital disease, just as if the virus had been communicated through the ovum or spermatozoa. In the later months there is a possibility that the child may escape.

Congenital Syphilis

The symptoms of congenital syphilis may make their appearance before birth or shortly after it, from three or four weeks to six months. In the former case, the child is nearly always born dead. It is quite the exception to find any evidence of the disease upon a child born alive.

1. *Before birth.*—It is probable that in a large proportion of the cases the death of the fœtus is due to disease of the uterus or placenta, the fœtus itself showing no definite sign. In a few, however, suppuration has been found in connection with the viscera: gummata are occasionally present, and certain changes, which are admittedly syphilitic, have been recorded in the bones.

2. *After birth.*—As a rule, the child is born without the least evidence of any taint, healthy and well-nourished, and no sign of the disease makes its appearance for some weeks. Exceptionally, *pemphigus* breaks out within a day or two and nearly always proves fatal.

A few weeks after birth the child begins to waste and grow pale. Its nose becomes stuffed up, so that it cannot take the breast for any length of time without letting go; a thin watery discharge runs from it, the breathing becomes obstructed (whence the popular name, *snuffles*), and a *rash*, similar to that which occurs in the secondary stage of the acquired form, makes its appearance more or less all over the body. The favourite situations are the mucous membrane of the nose, mouth, and anus; the skin over the buttocks, owing to the generally moist and heated condition in which that part is kept; and the palms of the hands and the soles of the feet. On exposed surfaces it is for the most part roseolous in character, not bright, but a dull coppery red; where the epidermis is thicker it forms circular scaly rings (miscalled psoriasis); between the nates and in other parts it assumes the form of condylomata, and in the mouth and at the anus it resembles, and is often associated with, thrush. At the angles of the mouth and nose it leaves deep fissures and cicatrices, and between the toes it forms rhagades: in other words, it exactly resembles the secondary eruption of the acquired form, modified by the peculiar condition of a baby's skin.

The peculiar colour and polymorphic character of the eruption, the wasting and aged look on the countenance, the coincidence of snuffles, and the symmetrical character of the affection, render the diagnosis easy when all are present together. It is very difficult, however, in some cases. Wasting is sometimes absent, the child remaining bright and well-nourished throughout the attack. Coryza is often present without syphilis, and, owing to the small size of the nasal passage and the thickness of the mucous membrane, may lead to distinct snuffles; while eczema and intertrigo are frequently symmetrical, and in some children are dull red instead of bright.

In severe cases the bones are affected as well. *Craniotabes*, wasting of the occipital and posterior parietal segments of the skull, so that in parts where the convolutions are prominent the bone completely disappears, is probably more often due to rickets than syphilis, but there are other affections which are definite. *Parrot's nodes*, periosteal swellings round the anterior fontanelle, one on each side, in front and behind, so that the situation of the fontanelle itself is marked by a cruciform sulcus, are characteristic. Similar affections on the shafts of the long bones are equally definite, though they are more uncommon. *Infantile pseudo-paralysis* cannot be mistaken: a soft tender swelling forms round one or more of the joints, especially the elbow, and the child becomes entirely unable to move the limb. The lower end of the humerus is in a state of gelatiniform degeneration, the cartilage is enormously thickened, and forms a soft translucent layer between the epiphysis and the shaft, so that a sensation of yielding and even of soft crepitus is present when the part is handled. Similar degeneration occurs, exceptionally, in the cranium.

Bone lesions of this description make their appearance, for the most part, within the first three months; after six they are much more rare. At the same time, *gummata* are occasionally met with in the viscera, but rarely, or never, in the subcutaneous tissues.

After the first year, until the commencement of puberty, there is a period of almost perfect freedom. I have met with one or two cases of condylomata and of small gummata in children five or six years old; and choroiditis is occasionally found (or rather the results of it, for it may have occurred at an earlier period); but with the exception of these it is the rule for there to be no manifestations of any kind.

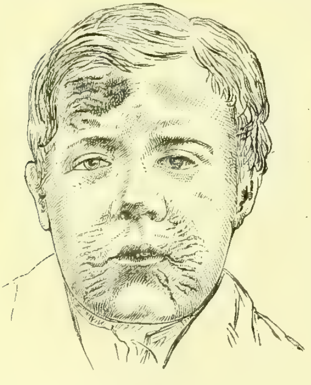

Fig. 2.—Hereditary syphilis, from life.

Signs of old mischief are common, and persist more or less distinctly throughout life (fig. 2). *The bridge of the nose* is flattened and wide, owing in all probability to the inflammation of the mucous membrane in infancy having spread to the periosteum and interfered with its proper development. *The angles of the mouth* are marked with radiating scars, and here and there upon the lips are little dead white cicatrices. The *permanent teeth*, especially the upper incisors, are notched in a most peculiar manner. The cutting edge, instead of being straight with two or three little serrations, is concave from side to side; the whole of the tooth is dwarfed, and, especially at the sides, somewhat bevelled off from above downwards, so that it has a peg-shaped appearance. This change, which was first described by Hutchinson, is characteristic: it very rarely, if ever, occurs under any other circumstances, and it is caused by and is proportionate to the stomatitis of infancy. If this is severe at the time the dental papillæ are developing, they are so much reduced in size and so altered in shape that it is almost impossible to recognise them as teeth at all. Mercurial teeth, in which the enamel is defective transversely, and marked by horizontal darkened grooves and pits, are totally different, but it is not uncommon to find the two associated. In exceptional cases, in which the stomatitis has been late or prolonged, a similar change is visible in the lateral ones as well; but it is only the median of the upper jaw that are definite and characteristic.

At puberty there is often a fresh outbreak; some of the lesions being distinctive, others resembling those of the tertiary period.

Of the former the most important are *interstitial keratitis* and *ostitis.* A symmetrical form *of deafness*, quite incurable, is also met with, but more rarely. The keratitis always attacks both eyes, although one is usually in advance of the other, lasts a variable number of months, and then clears up again, leaving, unless it has been very severe, little permanent defect. The ostitis is more intractable. It always attacks the shafts of the tibiæ, one or both, although it may appear in other bones as well. The shin grows out first and becomes tender; the leg seems to bow forwards; then the whole shaft enlarges, and in a few months, or two or three years, the bone stands out, misshapen, massive, enormously thickened, and often increased in length. In the milder cases, the exudation is diffuse and becomes organised; in the more severe ones, gummata are present as well, especially on the periosteal surface, and cause superficial sequestra, which separate with the most extreme slowness. Possibly this is due to the sclerosis, which may also account for the fact that iodide of potash is almost without influence; it relieves the pain for the moment and causes the gummata to diminish in size, but it does little or nothing more. In the worst of all the inflammation spreads to the ends of the bones, synovitis sets in, and at length, after lasting many years, with constant attacks of pain, the limb is reduced to a condition resembling an old gnarled tree-trunk, covered all over with cicatrices. In the tibiæ this condition is very common and is absolutely distinctive; in other bones it is more rare, periosteal and myelitic gummata, resembling those of acquired syphilis, occurring instead. Very often the effect is rendered still more striking by the peculiar undeveloped condition of the skeleton. Congenital syphilis in this respect closely resembles rickets; not only do the bones of the extremities and face fail to grow, but they do not undergo the proportionate development of adult life; the type remains that of the child.

There is no lesion in acquired syphilis that is not also met with sometimes in the hereditary form. The skull may be almost destroyed by necrosis; iritis, choroiditis, and optic neuritis may occur; ulceration of the soft palate and perforation of the hard one, with necrosis of the septum and turbinate bones are not infrequent, causing the most fearful ozæna. Gummata—visceral, subcutaneous, and muscular—are of common occurrence. Skin diseases however, with the exception of a rapidly spreading form of lupus, are rare, and the same may be said of the degenerative lesions of the nervous system. I have met with ophthalmoplegia (complete) in a girl sixteen years of age, in whom the only evidence of disease past or present was the presence of a few cicatrices at the angles of the mouth; but probably many of the cases of epilepsy, idiocy, and other diseases of the nervous system are merely coincidences, at least there is no direct evidence to connect them with the hereditary taint.

Treatment.—Excision. There is some evidence in favour of the view that early excision can prevent the further development of the disease; but it must be done within forty-eight hours, or three days at the utmost, and cases in which this is possible are altogether exceptional. By the time the chancre has developed it is certainly too late, and in this respect the analogy with such diseases as malignant pustule fails completely.

1. *General.*—The general principles of treatment are easily laid down. Mercury and the iodides of potash, soda, and ammonia, are the only drugs that exert any direct influence upon the syphilitic virus and its effects; the details vary very widely. The first named is chiefly of use in the earlier stages of the disease, although there are many cases in which its action is beneficial throughout; it seems to act as a specific, causing the primary induration to melt away much more rapidly than it otherwise would; delaying in a most remarkable manner the appearance of secondary symptoms; not unfrequently preventing them altogether, and rendering the whole course of the disease very much more mild; but it must be given with proper care. There is no doubt that if used in an indiscriminate fashion, it is capable of producing the most ghastly results, necrosis of the bones of the face, for example; and also that certain people are peculiarly susceptible to its influence. Their number, however, is exceedingly small; if sufficient precautions are taken they run practically no risk; and the danger is completely out-balanced by the extraordinary good it does to the majority.

How mercury should be given does not really seem of much importance so long as the method adopted agrees with the patient, brings him quickly under the influence of the drug, and is fairly convenient. It should be commenced at once, as soon as the diagnosis is made. It is true that sometimes of themselves secondary symptoms fail to develop after a hard chancre, but the prospect of this is too remote, and there is some evidence in favour of the view that, possibly because of the neglect of specific treatment in the earlier stages, cases of this kind not unfrequently suffer much more severely later. The administration should be continued, quietly but steadily increasing the amount, until the patient is definitely brought under the influence of the drug—until, that is to say, the teeth begin to feel too long, and it is painful to bite a crust; beyond this stage of incipient salivation it should never be carried. The treatment must be kept up with occasional intermissions until all the secondary symptoms, and especially the glandular enlargements, have disappeared. After that it may be dropped, although in most cases a short course, for a month or so, is advisable two or three times in the next two years.

Salivation, when it is rapidly induced, sometimes causes local lesions to disappear in a marvellous manner; but it has little or no influence upon the general disease; it compels the administration to be suspended at once; and there is some evidence to show that, even when it is not pushed as it was in days gone by, it is exceedingly injurious, tubercular eruptions and rupia making their appearance afterwards, during the period of forced inaction that must follow. The object at the present day is to begin very gradually, feeling the way as it were, and to keep the patient under the influence of the drug for a considerable length of time, without ever pushing matters so far that it must be left off. As soon as the point of incipient tenderness is reached the dose must be diminished and everything done to prevent the condition of the gums becoming worse. In this respect patients differ very greatly from each other. Independently of individual peculiarities, which sometimes are so strongly marked as almost to prevent the drug being taken at all, a great deal depends upon the condition of the teeth and the mode of life. If the teeth are decayed, or if there is a collection of tartar round them, tenderness begins much earlier, and the red line of incipient inflammation is distinct much sooner than when they are perfect; if, on the other hand, they have been lost from any cause, it is very difficult to affect the gums. Hutchinson has also pointed out that salivation is much more readily induced when a patient is confined to bed, than when he is going about his every-day work; and that it is distinctly checked by the use of tonics. Abroad, where mercury is pushed to a much greater extent than is usual in England, especially for tertiary affections, strong astringent gargles are used to check the tendency.

The simplest and most convenient method is by the mouth in the *form of pills*. Hyd. c. cret. (gr. ij. three times a day) hardly ever disagrees, especially if given with a grain of Dover's powder, and this may be continued for many months without causing the least disturbance, gradually increasing the frequency of the dose (rather than the amount) if the patient does not resent it, and the effect is not sufficiently rapid. Many patients are decidedly more comfortable and feel better while they are taking it, very probably from the action of the drug upon their liver. A grain, or a grain and a half, of blue pill, with a small quantity of opium, may be used in the same way. Others prefer calomel, or the green iodide; but the latter is distinctly more inclined to cause purging.

Inunction is chiefly useful in those cases in which, in spite of the addition of opium, mercury persists in causing dyspepsia, loss of appetite, or diarrhœa. Otherwise it does not possess any real advantage; and, although they will put up with it abroad, when they devote themselves entirely to their own treatment, most patients object to it in England as intolerably dirty. Twenty to forty grains of mercurial ointment are rubbed in, at first every other day, and then, if the effect is not sufficiently rapid, every day; the sides of the chest and abdomen, and the inner surfaces of the arms and thighs being the places usually selected, owing to the thinness of the skin and the absence of hair follicles. Flannel should be worn afterwards, and the part should not be washed for twenty-four hours. Care should be taken to change the locality frequently, for fear of causing an eczematous eruption.

Fumigation with calomel may be tried with advantage where there is a copious skin eruption. The ordinary apparatus is a spirit lamp, with, over it, a metal saucer containing a small quantity of water; and in the middle of this a metal disc on which the calomel (twenty grains) is placed. The patient is seated on a chair with a macintosh, or, if this is not available, a blanket wrapped round him, reaching from the neck to the floor. When the lamp is lit, the water evaporates first, producing copious perspiration, and then, as soon as the disc becomes sufficiently heated, the calomel sublimes in the form of a fine vapour, and is deposited upon the skin while this is in a condition well-prepared to receive it. If the throat is affected the patient may take the opportunity of inhaling some of the vapour. Afterwards, as soon as the sublimation is complete, the patient should be wrapped up warmly, and placed in bed without being wiped.

Hypodermic injection of bichloride of mercury (gr. $\frac{1}{3}$) into the substance of the muscles is used to a considerable extent upon the Continent, but has not found much favour in England owing to the pain and risk of suppuration.

Whichever plan is adopted, it is absolutely essential that the patient should exercise the greatest care about his manner of living. Stimulants are better withheld altogether; old claret is the least objectionable. Everything that tends to disturb digestion must be avoided; rules for this, of course, vary with the individual. Clothing should be warm; exposure, especially at night, carefully guarded against, and a fair amount of time allowed for sleep. Warm baths should be taken twice a week at night; but if the patient is accustomed to it, there is no objection to the cold bath in the morning, always provided the reaction is good. When the skin eruption is of an obstinate character vapour baths, or small doses of pilocarpine, sometimes effect a rapid improvement. Smoking is strictly prohibited; it is almost impossible to cure a tongue or a throat that is constantly being irritated with hot tobacco-smoke. Exercise in the open air is very essential; and where the patient's circumstances admit of it, residence at the seaside, or better still a sea voyage, is of very great benefit. Rupia, in particular, frequently resists everything until the patient goes to the sea. It cannot be too strongly impressed upon those suffering from syphilis that the only prospect of cure is early and thorough treatment, and that proper attention to their general condition is quite as important as the administration of mercury.

The iodides are of little use at the commencement of the disease. It has never been proved that they exert any special influence upon the primary induration or the secondary eruptions. On the other hand, when the bones are involved and in the later stages, when there is a cellular exudation of a chronic character, rather than acute hyperæmia, they give relief almost at once. It is not claimed for them, as it sometimes is for mercury, that they are able to cure syphilis; their influence is rather upon the manifestations of the disease than the disease itself; but in their proper place they are scarcely less valuable, and when mercury cannot be taken are practically the only drugs to rely upon. Iodide of potash is the one usually selected, but the corresponding salts of sodium and ammonia are equally powerful and possess the advantage of not being so depressing in their action.

The dose varies from a grain to a drachm or more three times a day. Small ones should always be used at the beginning; if they do not succeed the amount may be increased step by step, and it is not uncommon for a distinct improvement to follow each addition, but the dose that is reached in this way is often enormous. A large one at first might be unnecessary and very possibly harmful. Many patients are peculiarly affected by it. It nearly always brings on a profuse watery coryza with irritation of the conjunctiva; but usually this subsides in the course of a few days, even if the drug is continued. Exceptionally it is severe, not abating in the least, and is associated with such intense depression that patients absolutely refuse to take any iodine at all. This occurs especially with the potash salt, and although it may be to some extent obviated by the addition of carbonate of ammonia, it is better in such cases always to prescribe the soda and ammonia ones instead.

Cutaneous eruptions are frequently caused by the iodides, the three in this respect being apparently equal. Acne is the most common, occurring upon the usual situations, the face and shoulders; but much more severe vesicular and bullous eruptions are sometimes met with; and purpuric spots occasionally make their appearances upon the lower extremities. Wasting and diminished sexual power are not uncommon during the administration, but the effect is not a lasting one; and cases in which atrophy of the testes or the breasts is stated to have followed are for the most part open to suspicion.

The bichloride of mercury and iodide of potash are frequently given together (forming a biniodide soluble in excess of the potash salt), especially in the later stages of the disease, when it is wished to continue the use of the drug for a considerable length of time without risk of salivation.

Other drugs are of use in individual cases. Iron is the most general. By itself it has little or no effect upon the anæmia, but with mercury it very soon brings about a complete change. Arsenic is sometimes useful, but there is no proof that quinine or sarsaparilla has any influence upon the disease. Cod-liver oil, quinine, and other tonics are frequently required in the later stages, but according to Hutchinson they rather delay the action of mercury at the commencement.

2. *Local and special treatment.*—This is equally important; it often happens that an eruption or a sore which resists everything internally yields at once to local applications.

Lotio nigra, or a very weak mercurial ointment, is the best application for a hard *chancre.* The ordinary mild forms of secondary eruption disappear rapidly as soon as the effect of the mercury begins to make itself felt; but the more severe ones, particularly in the later stages, when there are local causes at work, require something further.

Sore throat, ulcers in the tonsils, and roseolous spots on the mucous membrane of the mouth, may be treated with a gargle of equal parts of chlorate of potash and lotio nigra; or of bichloride of mercury (gr. $\frac{1}{4}$ ad ℥j.) and bark. Calomel fumigation is useful where there is obstinate ulceration in a specially inaccessible part. The drug is placed in a glass tube drawn out to a fine point at one end, and at the other connected with an ordinary ball syringe. The calomel is vaporised by means of a spirit lamp, and a gentle current of air sent through the tube, so that a thin film is deposited in any spot that requires it.

Condylomata and mucous patches must be kept dry. Equal parts of calomel and oxide of zinc may be dusted over cutaneous ones. When they occur upon the tongue they can be painted over with a solution of bichloride, (gr. ij. ad ℥j.) or of bicyanide of mercury (gr. v. ad ℥j.). Cracks and painful fissures at the angles of the nose and lips may be cured, as a rule, by a single application of nitrate of silver (solid); but they tend obstinately to return.

Phagedæna and the spreading form of syphilitic lupus require iodoform and continuous warm baths; or, if they occur upon the face, the acid nitrate of mercury freely applied. The pain is relieved to some extent by cocaine. Sometimes the chronic persistent variety requires scraping.

Rupia is the most difficult of all the early syphilitic manifestations. It is most common in the intemperate and those who have been salivated; but sometimes it breaks out without apparent reason. Very small doses of mercury seem to agree with it best, sometimes in conjunction with iodide; but whenever it is possible the patient should be sent to the sea, and made to lead a perfectly healthy and temperate life. Iodoform is the best local application to the ulcers as soon as the scab can be detached.

Palmar and plantar *psoriasis* may be treated either with an ointment of the ammonio-chloride of mercury (gr. xv. ad ℥j.), or with the ordinary blue ointment, a piece of rubber or other impervious plaister being fixed over the whole dressing, so as to ensure the softening of the epidermis and the absorption of the drug.

Early secondary *periostitis* disappears in a day under the influence of the iodide. The later affections of bone do not get well so readily, but the pain can usually be relieved at once. Sclerosing ostitis and hyperostosis in hereditary syphilis are exceptions; iodide seems scarcely to have any effect upon them. If there is a gumma on the bone the exudation is absorbed, but the inflammation seems to progress unchecked beneath. Subcutaneous division of the periosteum, and linear osteotomy, are occasionally resorted to when the pain is severe, but the benefit is rarely more than temporary. Mercury is equally powerless, and local applications, with the possible exception of the actual cautery, answer no better. Fortunately the pain seems gradually to wear itself out after a time; in all probability the tension and compression of the nerve filaments at length cause atrophy; but it may be years before this happens.

Gummata and serpiginous ulcerations in the tertiary period require iodide freely. Small quantities of mercury are exceedingly beneficial at the same time, either applied locally in the form of black wash, or given as the biniodide, internally. This is particularly useful where it is desired to keep up the administration for any length of time.

In chronic affections of the *nervous system* it answers best to begin with small doses of mercury, and gradually to push it until a distinct effect is produced upon the gums. If this cannot be borne, iodide must be given; but, alone, it rarely succeeds so well. After a certain time the biniodide may be tried and kept up for a year or more. Relapses are very common.

Iritis and neuroretinitis require the administration of mercury to be pushed vigorously. In cases such as these it is necessary to check the exudation as soon as possible.

In the inherited form either small doses of hyd. c. cret. may be given night and morning; or inunction may be tried, a small quantity of mercurial ointment being placed inside a flannel binder sewn round the body. Iron is usually very beneficial at the same time. The later affections that appear at puberty must be treated as the tertiary ones of the acquired form; but they are seldom so tractable, and usually require mercury in addition to the iodide.

If the attack is recent, or if there have been recent miscarriages, small doses of mercury should be taken during the whole course of pregnancy. If the father is infected precautions of a similar character should be adopted. Marriage should on no account be sanctioned until at least two years have elapsed from the original attack and six months from the disappearance of the last symptoms.

LEPROSY

Leprosy is a contagious disease, very chronic in its course, in many respects analogous to syphilis, and caused by a specific bacillus, which resembles that of tubercle in its behaviour to staining reagents, though its size is smaller.

The disease is very widely spread. Formerly it was common in England and Scotland; at the present day it is only met with when imported. In Norway, Iceland, the East and West Indies, Palestine, and other countries, it is of frequent occurrence. It is not connected with diet, climate, syphilis, malaria or other diseases, except in so far as they lower the vitality of the tissues and weaken their power of resistance. Heredity is doubtful; but there is no question as to its being contagious, although probably individual predisposition varies very considerably.

Pathology.—The essential feature in all the lesions, no matter how much they differ in appearance, is the production of masses of granulation-tissue, similar to that formed in tubercle and syphilis, with giant-cells, round-cells, and all the intermediate varieties that occur as a result of chronic irritation. The so-called lepra-cells are merely leucocytes, connective-tissue corpuscles, or epithelioid cells from the interior of the lymphatics or capillaries, transformed by the action of the bacillus; every grade can be found, between the leucocyte with the single germ and the lepra-cell with myriads. The subsequent development depends partly upon the stage of the disease, partly upon the condition of the patient, and the presence or not of other organisms, especially those that cause suppuration. The newly-formed granulation-tissue is never very well supplied with vessels; even at the commencement of the disease it wastes away, undergoing caseation and absorption, or developing into dense fibroid tissue; later it breaks down, suppuration sets in, and not unfrequently phagedænic ulceration with immense destruction follows. The changes are the same, whether it occurs upon the skin, in internal organs, or on mucous surfaces, the internal complications to which it gives rise not uncommonly proving the immediate cause of death.

Symptoms.—Leprosy exists in two forms, the tubercular and the anæsthetic: the former is the more common in temperate climates, the latter in the tropics; but there is no essential difference between them, and they may occur in the same patient as a mixed form. The bacillus has only been proved to exist in the tuberculated variety.

Certain vague prodromata, which may last months or even years, are present in both. Chills with occasional attacks of fever, but very rarely anything like a genuine rigor, weakness, drowsiness, and vertigo, are the most common, varying from time to time, and indicating little more than a general failure of health. The local symptoms are characteristic.

1. *The tuberculated variety.*—The skin and subcutaneous tissue usually suffer first, especially on the face; then the mucous membrane of the mouth, tongue, and larynx; finally it becomes general.

Erythematous patches, little nodules, tubercles, and finally giant masses the size of an egg and even larger, make their appearance in successive crops, gradually getting worse and worse, and each outbreak attended with a feverish attack. At first the skin only is involved; dusky, red, slightly raised patches of various size, associated with hyperæsthesia form upon the face, forehead, arms (especially the extensor surface), and legs. They are fairly well defined at the margin, and after lasting some little time disappear, leaving the skin where they were pale, pigmented, and atrophied. The hyperæsthesia disappears with the exudation, and is succeeded by distinct impairment, but there is no general anæsthesia as in the other form.

Then, as the disease advances, these are succeeded by crops of dusky red or brown nodules and tubercles, scaly upon the surface, and involving the deeper tissues as well as the skin. The smaller and earlier ones disappear as before; the larger ones, although they too may become absorbed, not unfrequently break down and suppurate, forming deep, red, and glazed ulcers, which heal very slowly. By degrees, as the tubercles become more frequent and larger and the surrounding inflammation more severe, the aspect of the face is completely changed. The eyelids, nose, lips, and ears are enormously increased in size, and distorted by great bosses and masses of odematous tissue interspersed with scars. The forehead is covered with folds of thickened hypertrophied skin : the hands and arms and the trunk are more or less deformed in the same way. The general health fails; strength and energy are lost; sexual power disappears, and a condition of complete prostration follows.

Other symptoms are caused by similar eruptions upon the mucous membranes. The voice becomes altered: ozæna sets in from ulceration of the nose; diarrhœa is not uncommon; pulmonary complaints follow from the inhalation of foul and putrid discharges; and the immediate end is not unfrequently caused by some low type of inflammation consequent upon phagedænic ulceration of the mouth and fauces.

2. *The anæsthetic variety* is attended by similar prodromata. The local symptoms, however, are traceable almost entirely to disease of the nerves.

Patches of hyperæsthesia, with shooting pains and eruptions of small bullæ upon the hands, forearms, and legs, are the earliest sign. The skin of the fingers becomes glossy and red, and the muscles waste, corresponding to the distribution of one of the nerves, especially the ulnar or median, which can often be felt enlarged. Then dry, yellowish-white, scurfy spots appear upon the back and shoulders, and over the knees and elbow. In the centre of each sensation is lost; round the margin, which is often raised and even vesicular, there is for the time some degree of hyperæsthesia. These keep increasing in size and number; the area of anæsthesia slowly spreads, muscular wasting becomes more rapid; the joints become stiff and contracted; and finally, after many years' duration, the skin over the whole body may be atrophied, dry, and white or yellow according to the depth of complexion.

Bullæ are not uncommon here and there upon the exposed parts; perforating ulcer may occur upon the foot; severe injuries are often sustained owing to the total absence of sensation, and dry or moist gangrene occasionally sets in and follows its usual course, according to the presence of septic decomposition or not.

In addition, the most extraordinary deformities are caused by absorption and wasting. The phalanges of the fingers may disappear until the nails rest upon the ends of the metacarpal bones; the hand may assume a peculiar claw-like form from atrophy of the interossei; drop-wrist may occur; the toes may disappear; and what with gangrene, wasting, interstitial absorption, and ulceration (which, however, is rarely so severe as in the tuberculated form) the most extreme degree of mutilation may be produced.

The immediate cause is the infiltration of the growth into the substance of the nerves, giving rise at first to irritation and hyperæsthesia, later to wasting with anæsthesia and degenerative changes, the exact locality of the symptoms depending in each case upon the fibres involved.

Treatment.—A certain amount of improvement is stated to have followed the administration of Gurjun oil (in lime water, 3 grs. twice a day) and Chaulmoogra oil (in perles, each containing three minims), gradually increasing the dose until the patient's limit of endurance was reached; and this may be combined with their external application. Druitt recommends the oil from the *Hydnocarpus inebrians* (known as Kauti), but apparently by report only. For the rest, all that can be done is to treat symptoms as they arise, paying special attention to hygienic measures and trying to check ulceration as far as possible. In the anæsthetic variety temporary improvement has been obtained by nerve-stretching and nerve-splitting, the operation probably acting by releasing the fibres from constriction or pressure.

TETANUS

Tetanus is a disease characterised by tonic contraction of voluntary muscles, either those belonging to a single group of actions or those of the whole body. It usually follows a wound, but as this may be of the most trivial description—a mere pin-prick, for instance—or be wanting altogether, it cannot be regarded as essential; and it may be acute, proving fatal within a few hours; or chronic, lasting for days or weeks.

Various terms are applied to it, according to the muscles involved. It is known as *trismus* when those connected with mastication are rigid (whence the popular name, 'locked jaw'): and as *trismus nascentium* or *neonatorum* when it occurs shortly after birth. If it follows an injury to the head it is sometimes described as *tetanus hydrophobicus*, owing to the spasmodic contraction of the muscles of deglutition which is occasionally present; and as *opisthotonos* when the head is thrown back; *emprosthotonos*, when the body is curved forwards; and *pleurosthotonos* when it is thrown to one side. These terms, however, are merely descriptive, and the two last conditions are exceedingly rare.

Etiology.—Tetanus is especially common in certain races, and in certain climates, but it may attack any one. Lacerated wounds, those in which there is a foreign body embedded, and gunshot injuries of the lower extremities, are said to be more often followed by it than others, and decomposition appears to be favourable to it; but it may occur without an open wound (as in simple fractures) and even without an injury of any kind. Exposure to cold and wet or to great changes of temperature is usually stated to be a cause, but it may be merely a predisposing one. No doubt cases frequently occur together, and at times well-marked epidemics of tetanus have been recorded; but whether this is due to contagion or to the fact that the patients were simultaneously exposed to the influence of the same agencies, is not clear. It is a very common disease in horses and cattle generally, but dogs seem especially exempt.

There are two views with regard to its pathology: the one, that it is due to an abnormal condition of a peripheral nerve, which either extends directly to the spinal cord or causes general reflex spasm; the other, that it is the product of some poison excreted by a living organism. Neither can be considered proved, and not improbably there is an element of truth in both.

(A) The former rests chiefly on clinical evidence. There is a certain small but undoubted number of cases in which a distinct nerve lesion has been found (a foreign body, for example, pressing on a nerve or embedded in it) and in which the symptoms have subsided after its removal. It has been known to occur even in simple fractures from the pressure of a displaced fragment.

Further, distinct improvement occasionally follows nerve section, although unhappily the number of acute cases in which this has taken place is very small. The success that sometimes attends excision of the wound or amputation does not point to anything, for it may be explained by the fact that the poison is to some extent a local production, as in malignant pustule.

Sometimes in man, and to a much greater extent in animals, the tetanic symptoms, instead of beginning as trismus, show themselves first in the injured limb, and even in the muscles that correspond with the distribution of the injured nerves—in the biceps, for example, when the musculo-cutaneous nerve is involved. This again cuts both ways, and is capable of being explained on either theory.

The same may be said of the fact that occasionally in tetanus, spasmodic attacks may be excited by pressing upon the trunk of the nerve that is believed to be affected; upon the ulnar nerve at the elbow, for example, when the injury affects the little finger. This merely shows that when the nervous system is in the peculiarly excitable condition produced by this disease, the slightest stimulus can call forth an entirely disproportionate result.

Nor is it of much importance that in a few exceptional cases evidence of nerve irritation (swelling, hyperæmia, cellular infiltration, &c.) has been found in the region of the wound. If tetanus can be caused by mechanical irritation of a peripheral nerve, it should be much more common than it is; it should follow neuritis and operations upon nerves; and sutures and ligatures, which must often involve nerve filaments, should constantly give rise to it, for the smallest wound is enough. Moreover, the actual number of cases in which any evidence of this kind has been found is exceedingly small; in the great majority, the condition of the nerves round the seat of injury presents nothing abnormal; and in a certain proportion there is no injury at all. In short, it must be admitted that, although it is at present impossible to explain some cases, the theory that tetanus can be caused by mechanical irritation only is not proved.

(B) There is more evidence in favour of the other view. The fact that the disease is distinctly endemic as well as epidemic, that it occurs again and again in certain hospitals and in certain wards, until suddenly there is some alteration—some improvement in the ventilation, perhaps—is most suggestive. Of children born in the Rotunda at Dublin, at one time no less than seventeen per cent. used to die from it; and epidemics on a smaller scale have been recorded in connection with many other institutions.

The existence of an incubation period again deserves consideration. It is true it is most irregular; the disease may break out within a few hours after an injury, or not occur for weeks; but when the conditions are the same—in new-born children, for example—there is such uniformity that in some parts of the country the disease is known as 'nine-day spasms.' Moreover, it is not a little singular that, as a rule, the attack is milder, the course more chronic, and the prognosis better, in proportion to the length of time that has elapsed since the receipt of the injury. Acute cases rarely survive; chronic ones and those that are not due to a wound not uncommonly. It would almost seem as if the shortness of the incubation period and the virulence of the poison were in some way connected with the tissue-changes that occur soon after the infliction of a wound.

The results of experiment are more definite. Although there is a certain amount of discrepancy, the balance of evidence is distinctly in favour of its being due to a form of bacillus, living in moist earth, widely distributed, and closely associated with the bacillus of putrefaction, so that it is exceedingly ifficult to obtain a pure cultivation. It is found chiefly in the immediate egion of the wound (a fact which may be of some significance in connection vith treatment); the blood is rarely infective, so far, at least, as animals are oncerned (in men this is not so certain, especially when the disease is cute); evidence of its existence has been found in the spinal cord and medulla blongata; and it can be cultivated in proper media, although with some ifficulty.

The disease has been produced in other ways: by the hypodermic intro-uction of earth; by using in the same way fragments of tissues and wash-ngs of wounds from patients who have died from the disease; by inoculations vith dust (it is recorded that out of seventy people injured in a church during n earthquake at Bajardo, no less than seven were attacked by tetanus, and hat animals inoculated with dust from the same place suffered in the same vay); by a culture obtained from a splinter of wood that had already caused n attack of tetanus; and by using some of the dried discharge from a pair of orceps that had been employed in castrating horses.

It is true that there is some discrepancy about the form of the bacillus: ome observers have been unable to find it at all; some have succeeded with lood, others not; some have found it necessary to make use of subdural in-ections, while with others hypodermic ones have answered better; and mulsions of the spinal cord are according to some innocuous, according to thers certainly fatal. For all that, the broad facts must be admitted, that he disease (or one so strikingly like it that it cannot be told from it) can be aused almost at will by the injection of certain substances which usually ontain the same form of organisms. In all probability it is really due to ertain albumoses which have been extracted from cultivations, and which ave been shown to be capable of causing tetanic convulsions. That the isease in animals usually begins in or near the seat of inoculation is not eally very much to the point, for such cases, though they may be rare, are ertainly met with in man.

The post-mortem appearances in tetanus are not distinctive in any way. ccasionally evidence of neuritis is found, but it is decidedly rare; rupture f muscles and engorgement from asphyxia might be expected. In one or wo instances curious rounded points visible to the naked eye have been ound in the spinal cord and medulla oblongata; they stained readily with armine and logwood, were apparently homogeneous, and pushed aside the erve fibres round them; but it is not known what significance is to be attached to them. Dilatation of the perivascular lymphatics in the brain has also been described.

Symptoms.—Premonitory symptoms are rare. The first definite sign is usually pain and stiffness about the muscles of the jaw and neck; the patient complains of sore throat or stiff neck, and imagines he has caught cold. Then it is noticed that the mouth cannot be opened to its full extent, though it can still be closed, and that mastication and deglutition are difficult. Every attempt brings on painful spasms, and seems to make the contraction worse. By degrees, sometimes rapid, sometimes slow, the painful contraction and the rigidity extend to other muscles near. The orbicularis oris may be contracted; more frequently the lips are drawn apart (risus sardonicus), the neck is drawn back so that the head bores its way into the pillow, the thorax becomes rigid and the abdomen hard and board-like; often there is a fearful pain extending from the ensiform cartilage backwards; respiration becomes shallow and rapid; the forehead is bathed with sweat; the pulse small and feeble; and the whole face expressive of the most intense anxiety and suffering.

Gradually, as the disease advances, all the muscles of the trunk become hard and rigid; the thighs and legs are extended or drawn apart, and the shoulders and arms thrown out. The fingers and wrists usually escape. Meanwhile the convulsions become more and more severe, and the intervals shorter. Paroxysmal attacks with the most violent contractions come on every few minutes, and with every sound or breath of air; the face is distorted; the body wrenched and twisted with the utmost violence into inconceivable positions; the limbs jerked wildly about, until at length the muscles themselves give way or are ruptured.

Consciousness is retained to the last. The pain in the acute forms is agonising. Sleep is impossible, except in short snatches from sheer exhaustion; it is said that then there is slight relaxation. The bowels are confined, the urine scanty; and towards the end the temperature often begins to rise, and it may continue after death until it reaches 112° F., or even more. Sometimes, just at the end, there is a brief lull in the severity of the symptoms, but no hope is to be derived from that. Death is generally due to asphyxia or heart-failure. If this does not happen, the exhaustion may be so extreme as to prove fatal of itself. In chronic cases the convulsions diminish in intensity until only a certain degree of tonic contraction is left; a relapse is always possible so long as the slightest trace persists.

Prognosis.—Acute tetanus is nearly always fatal; death may occur in four or five hours. After the fourth day the chances of recovery increase. Idiopathic tetanus and that which occurs late after the infliction of a wound are very much more hopeful.

There is rarely any difficulty in the diagnosis, although it must be borne in mind that a very severe form of trismus is not uncommon when the wisdom-teeth are coming through. In any case of doubt the interior of the mouth should be thoroughly examined under an anæsthetic. Hysteria, cerebro-spinal meningitis, attended with opisthotonos, and hydrophobia occasionally cause a little hesitation. The last mentioned is sometimes simulated very closely when tetanus complicates injuries of the head. Strychnia-poisoning reaches its maximum in the first hour, and then either proves fatal or gradually subsides.

Treatment.—The wound should be thoroughly explored, and if the injury is a recent one and the attack acute, excised. It may do no good, but there is some little evidence to show that the poison (like that of malignant pustule) is a local one, in a measure at least; and it certainly can do no harm. Nerve-section and nerve-stretching fail in acute cases, where their help is wanted.

The bowels should be opened thoroughly, once for all; the patient placed in a darkened room and kept absolutely quiet. If he can swallow, beef-tea, eggs, brandy, and wine may be given freely. If not, nutrient enemata must be tried. According to Sir Thomas Watson, wine in large doses, and nourishing diet, are more likely to succeed than any drug.

Chloral, and bromide of potash have undoubtedly some influence upon the severity of the spasms. Chloroform inhalation has been tried and kept up for hours, but with only a temporary benefit, if any. Curare has failed completely; opium is of very little use; Calabar-bean raised a certain amount of hope for a time; but no drug has the least effect upon the disease, though one or two may alleviate the most painful of the symptoms.

RABIES

Rabies (or hydrophobia, as it is called in man, from one of its prominent symptoms) is a specific disease resulting from the inoculation of the virus from a rabid animal. There is no proof that it ever originates *de novo*; it is always communicated, chiefly from dogs, cats, and wolves, although exceptional instances of its having been transmitted from herbivora are on record; and human saliva and human tissues have proved infective in the case of animals. Although the poison has not yet been isolated, there can be no doubt that it is the product of a living organism: it is contained in the saliva and in the blood, but its most certain habitat is the central nervous system; inoculations with the two former fail not unfrequently, with the latter very seldom; and it is capable of indefinite multiplication within the body. Certain people and certain dogs seem naturally to possess immunity; but probably this is not so common as at first sight it appears to be, many of the cases being really due to ineffective inoculation.

The only morbid changes that are found with any constancy are in the lower part of the medulla oblongata, round the respiratory and deglutition centres, and sometimes in the grey substance of the cord. They consist chiefly in perivascular infiltration, with granular degeneration of the cells themselves. Congestion of the brain is sometimes present; and the pharynx, fauces, and salivary glands are, in many instances, deeply injected and stained with blood.

Symptoms.—The symptoms of rabies in dogs differ in many respects from those of hydrophobia in man, but there is no doubt as to the identity of the two diseases.

In the former, the incubation period is rarely under a fortnight, very rarely over three months. At first there is merely an alteration in general behaviour; the animal is agitated and restless; it may still be obedient, but it is very irritable towards strangers; there is a constant tendency to gnaw everything and to swallow all sorts of substances; in some cases the wound appears to annoy it; and the bark is peculiar and characteristic, ending in a long-drawn howl. This in two or three days is followed by the second or furious stage, in which the animal, although it appears to wish to avoid injuring those it knows, seems compelled to bite at everything and everyone round. There is no fear of water; a dog will often plunge his head in and drink freely; but there are certainly hallucinations, coming on at intervals, although the animal is conscious and has not lost all control over itself. The final stage of paralysis soon follows, the strength rapidly failing, often in the hind legs first, and complete prostration setting in. In other animals the symptoms are very much the same, varying of course with the habits and general mode of life. In rabbits, for example, the first two stages are not present, and the disease begins with paralysis. Sometimes the same thing occurs in dogs, the so-called dumb-madness, and even in man.

In man, the incubation period is more variable. Without subscribing to cases in which it is said to have lasted ten years and more, there can be no doubt as to its having been as long as fifteen months. On the other hand, it may be only a fortnight, especially when the bite is on the face and the animal was a wolf, or what is probably nearly as bad, a cat. As might have been expected the shortest period is often associated with severe and extensive injuries. The wound may suppurate and appear unhealthy, but this is not due to the rabic virus; inoculation wounds performed with due precautions never give rise to inflammation.

The stages are the same as in the dog. A certain degree of uneasiness is often noticed about the scar; it may be red and irritable, and tingling sensations are not unfrequently complained of. This may last for two or three days before the depression begins, or it may be absent altogether. The patient becomes restless and uneasy, without being able to assign a cause; there is the most extreme depression; insomnia is of frequent occurrence; there is complete loss of energy, and in many cases irritability and general *malaise*. The second stage usually sets in suddenly with a feeling of fulness and constriction about the throat. There is no tonic contraction as in tetanus, but successive convulsive spasms, of the most violent character, involving particularly the muscles of deglutition and respiration, and excited by the least breath of air, or the slightest sound. Sometimes they are so severe as to threaten death from suffocation; often there is marked opisthotonos, but in the intervals there is usually complete relaxation. General hyperæsthesia is the rule; frequently there is great excitement of the sexual organs; hallucinations are of common occurrence, and the patient may be exceedingly violent, but there is rarely anything like mania; and intervals of self-control are nearly always present from time to time. The pulse is small and frequent; the secretion of saliva is profuse but viscid; the tone of the voice is altered; the urine is scanty, often containing albumen, and there is, as a rule, intense thirst, every attempt to alleviate it, or even the idea of drinking, bringing on violent convulsions. Gradually, after lasting perhaps forty-eight hours, the attacks diminish in severity; if life is sufficiently prolonged a condition of rapidly ascending paralysis sets in (probably, as pointed out by Horsley, the ascending paralysis of Landry was really hydrophobia) and the patient sinks, retaining consciousness more or less to the end. Death may occur during the second stage from asphyxia or from heart failure; it rarely happens that the case lasts more than four days from the first commencement of the actual symptoms, although in a few instances the patient has lingered for a week.

Although some of the symptoms, even the hydrophobia, are occasionally wanting, there is rarely any difficulty in the diagnosis. Tetanus, especially that form of it which sometimes follows wound of the head, resembles it more closely than anything else, but trismus is absent in rabies, and there are always periods of remission. Hysteria, hystero-epilepsy, and even mania have been mistaken for it; and there is a certain number of cases on record in which all the symptoms have been present, and in which death has followed, without its being possible to find any evidence or any history of inoculation.

Prognosis.—The disease, if left to itself, is absolutely fatal. No authenticated case of recovery, after the first symptoms have appeared, is known, at least in human beings; in one of Pasteur's experiments a dog recovered, and subsequently showed complete immunity.

What proportion of those who are bitten by infected animals suffer from the disease is very difficult to estimate. In the case of dog-bites it seems to be at the lowest estimate fifteen per cent.; cat-bites are worse; and wolf-bites, especially on the face, far worse still—no less than eighty per cent. of these are said to prove fatal. The length of the period of incubation varies in the same manner, but possibly this may be accounted for by the greater severity of the injury. Bites on exposed parts are more serious than when the teeth have to pass through several layers of clothes first.

Treatment.—A tight ligature should be placed at once above the wound, and bleeding encouraged as much as possible. It is not safe for anyone else to suck the wound, as the least abrasion of the mucous membrane is sufficient. The sooner the whole injured surface is excised or thoroughly cauterised the better.

No drug has the least influence upon the progress of the disease, although chloral and morphia may relieve the pain and diminish the severity of the spasms. The patient must be kept perfectly quiet in the dark; thirst must be relieved as far as possible by rectal injections—if, that is to say, there is the ordinary difficulty in swallowing—and any food that can be taken must be given. Tracheotomy is very rarely required, and such remedies as hot or vapour baths only serve to accelerate the end.

The only treatment of any service at all is the inoculation plan, discovered and perfected by Pasteur, and by which he has succeeded in reducing the mortality to 1·47 per cent. on the whole number (2,164); and to a very much lower figure still, if only the later cases, and those which applied for treatment soon after the injury, are reckoned.

The most recent and complete account of Pasteur's method is that given by Dr. Ruffer at the Leeds meeting of the British Medical Association. The virus is invariably present in the cerebro-spinal nerve-centres. If a rabbit is inoculated under the dura mater with an emulsion made from the medulla of a rabid dog, the first symptoms appear within fifteen days, never earlier than nine. If the medulla of this rabbit is used to infect a second, the period of incubation is shortened; and if this system is repeated eighty times, at length what Pasteur terms 'fixed virus' is reached, a poison, that is to say, which has a period of incubation of from six to seven days, and always proves fatal on the tenth.

The duration of life of the rabic organism is very limited. If the spinal cord of a rabbit that has died of hydrophobia is preserved in a sterilised bottle, the air of which is kept dry by means of caustic potash, the organisms gradually die off until after ten or eleven days no more are left alive; only the chemical products of their action are still there. An emulsion made from a cord in this condition is used to begin the treatment.

It has been proved that some pathogenic organisms, when growing in suitable media, produce chemical substances which, when injected into an animal, enable that animal to resist the action of the specific organism itself. The object that Pasteur had in view was, by treating the patient during the period of incubation, to render him insusceptible to the disease.

At first an attempt was made to effect this by injecting an emulsion of fresh spinal cord; this would contain living organisms, and their chemical products too; the latter would act at once, and confer immunity before the former had passed the incubation stage, but success was not certain.

By using a spinal cord that has been kept until all the organisms have died out, only the protecting substance is injected, although probably the quantity is small; and by repeated injections, each time making use of a cord that is one day less old than the one before (and therefore contains more both of the protecting substances and of the germs), at length a condition of complete insusceptibility is reached before the incubation period of the original infection is exhausted. Thus, on the first day of treatment an emulsion from a spinal cord dried for fourteen days, and another dried for thirteen, is injected ; on the second day an emulsion from one dried for twelve days, and another from one dried for eleven ; on the third, two more, one ten days old and one nine ; until, on the fifth day, a cord dried for six days only is used. The treatment is continued for sixteen days, each injection consisting of about half a cubic centimètre of spinal cord crushed in two cubic centimètres of sterilised beef-tea.

For most cases Pasteur found this course sufficiently rapid in its action, but not for wolf-bites, or bites upon the face. For these, what is known as the intensive method is employed, the same in principle but more rapidly carried out, four injections being made on the first day, four on the second, and two on the third, so that on the fourth day a cord is used which has only been kept five days. Of fifty patients treated in this way not one died.

Dr. Ruffer states in the most positive manner that no case is on record in which death has been produced by Pasteur's treatment.

CHAPTER V

TUMOURS

By Frederic S. Eve, F.R.C.S.

Cysts or cystomata.—A cyst may be broadly defined as a cavity with well-defined walls and fluid contents. The walls are composed of connective tissue and are usually lined with epi- or endo-thelium.

A cyst may be single or *simple.* Many cysts may be grouped together to form a *conglomerate* cystic tumour ; or a cystic tumour may be *multi-locular.* The latter term is applied when the mass is broken up into numerous cavities or loculi by partitions ; and this condition is produced either by fusion of adjoining cysts, or by the growth of secondary cysts within the walls of the primary cavities, as in ovarian tumours. The secondary cysts either project externally (exogenous cysts) or internally (endogenous). A cyst is said to be *proliferous* when a growth or vegetation springs from its walls into its cavity.

Cysts have commonly been classified according to the nature of their contents, as: sebaceous, mucous, serous, mucoid and colloid.

A primary classification, according to their source, seems preferable, as follows :—

I. Cysts arising in normal structures.

II. Cysts arising in persistent fœtal rudiments and misplaced fœtal structures (congenital cysts).

III. Cysts formed within or of the nature of tumour-formations.

I. Cysts arising in Normal Structures

The first class, which comprises the larger number, may be further subdivided, on an anatomical basis, thus :—

(*a*) Cysts formed by distension of serous sacs and synovial membranes, or of diverticula from the same ; and by distension of connective tissue interspaces (exudation cysts), i.e., hydrocele, ganglion and adventitious bursæ.

(*b*) By distension of mucous membrane canals, i.e., hydro-salpinx, dilatation of vermiform appendix, &c.

(*c*) By dilatation of ducts and glands (retention cysts), i.e., sebaceous cysts, ranula, spermatocele, and most of the cysts of the breast.

(*d*) By distension of normally closed follicles in glands, i.e., Graafian follicle cysts and some cysts of the thyroid gland.

(*e*) By dilatation and cutting-off of portions of blood and lymphatic vessels.

(*f*) By encapsulation of extravasations of blood, foreign bodies and parasites, i.e., arachnoid cysts, hæmatomata, hydatids, &c.

(*a*) The application of the term cyst to many cavities abnormally distended with fluid is purely arbitrary and founded on custom. Thus, among the first division, hydroceles are not usually described as cysts, although they are technically quite as much so as a dilated bursa patellæ. Among other examples of this class is the common ganglion, which is formed by distension of diverticula from the tendons of the dorsum of the hand and foot. Adventitious bursæ result from separation of connective-tissue bundles by exudation, the cavity becoming lined with endothelium.

(*b*) Hydro-salpinx or distension of the Fallopian tubes by fluid, and distension of the vermiform appendix, are familiar examples of cysts formed by dilatation of mucous canals.

(*c*) The cysts resulting from retention of secretion in normal ducts and in glands, or *retention cysts*, constitute surgically the most important group, of which the common wen or sebaceous cyst is an example.

Sebaceous cysts.—These are most common in middle life, and their seats of predilection are the scalp, back, shoulders and face. They are rounded or lenticular, fairly movable, and situated immediately beneath the skin, to which they are often adherent. Upon their surface the blackened orifice of a dilated hair-follicle may often be seen, and down this a fine probe may, in many cases, be passed into the cyst. The contents are a yellowish curdy material, either inspissated or semi-fluid, and showing, under the microscope, fat globules, fat crystals, and epithelial cells undergoing fatty degeneration.

Microscopically the walls are composed of an external coat of connective tissue lined internally with epithelium. The outer layers of cells are elongated and vertical; as the inner surface is approached they become flattened, undergo fatty degeneration, and finally form laminæ. The cysts are probably formed by dilatation of the hair-follicle with sebaceous secretion and epithelium, and not of the sebaceous gland or its duct. They not infrequently become inflamed and suppurate, and occasionally calcify; they may also become the seat of secondary growths which spring from their internal surface, namely—papillomata, horns, and epitheliomata.

The diagnosis of sebaceous cysts rarely presents any difficulties except from dermoid cysts. The latter can be distinguished by the fact that they lie beneath the deep fascia, and the skin is therefore freely movable over them; while sebaceous cysts lie within the corium and are therefore attached to the skin. The situation of the cyst, age of patients, and other circumstances of the case may also assist in forming a diagnosis.

Mucous Cysts.—Retention cysts occur on mucous membranes from dilatation of the follicles. They are met with on the inner surface of the lip, base of tongue, and on the floor of the mouth. Dilatations of Bartholini's glands on the female vulva, and very rarely of Cowper's glands in the male, may call for surgical interference.

Ranula should also be classed in this group, it having been shown to be due to dilatation of one of a pair of mucous glands lying beneath the mucous membrane of the mouth on each side of the tip of the tongue. They are known as the glands of Blandin and Nuhn. Ranula presents itself as a fluctuating swelling, covered with translucent mucous membrane, which projects from the floor of the mouth beneath the tip of the tongue, and extends backwards for some distance on one or the other side. The cyst may attain the size of a pigeon's egg. On opening it, a glairy fluid like egg-albumin issues from it. The fluid is rich in mucin, but does not possess the characters of saliva, since it does not give the test for sulpho-cyanogen and is incapable of transforming starch into maltose.

A cystic dilatation of Wharton's duct itself was actually demonstrated in a case by Richet, but there can be no doubt that the ordinary ranula originates in the glands of Blandin and Nuhn.

Dermoid cysts occur in the same situation as ranula, and can only be differentiated from them by the nature of their contents.

Retention cysts of glandular organs will be described in other parts of this work. I will only allude to the fact that in the breast, and perhaps in a less degree in the testis and kidney, they may be roughly divided into three classes :—

1. Evolution cysts due to anomalies of development—illustrated in the breast.
2. Cysts occurring in middle life resulting from sclerosis and chronic inflammation ; these are observed also in the breast and kidney.
3. Involution cysts accompanying the atrophy of senility in each particular organ and observed in the breast. I have also shown that spermatocele may be produced by the same process.[1]

(*d*) Cysts of the Graafian follicles at times resemble retention cysts, in that they are prevented from rupturing by adhesions, the result of periovaritis.

(*e*) Cysts formed by cutting-off of portions of blood-vessels are rare, and are found in connection with veins, especially the internal saphena ; one case has come under my own observation. Virchow records an example in connection with the internal jugular vein. A case of cystic dilatation of the lymphatic vessels of each groin in a youth aged 20 has been described by Trélat. The swellings had existed six years.

(*f*) Cysts formed around extravasations of blood, foreign bodies and parasites, are practically of the same nature, the encapsulation being due to the formation and organisation of granulation tissue. In illustration of the first I may allude to a very large and distinctly defined blood-cyst of the scrotum, which I described. It followed a kick and had existed sixteen years. Butlin has pointed out that many cysts formerly described as blood-cysts were probably soft sarcomata into which profuse extravasation of blood had occurred (*hæmorrhagic sarcoma*).

Proliferous cysts.—Many cysts, especially those of glandular organs and mucous membranes, may become the seat of solid growths, which spring from their inner surface. They occur frequently in cysts of the lacteal ducts, and the disease then constitutes the true *sero-cystic disease* of Brodie. The intra-cystic growths are softish and papillary on the surface. Under the microscope they usually show papillæ, between which gland-like tubules, either rectilinear or tortuous, extend downwards and give to the mass the appearance of an adenoma with scanty inter-cellular substance. Such cysts are usually innocent, but at times the growth is cancerous and infiltrates the surrounding tissues ; it then constitutes the disease described as *villous cancer*.

Proliferous or papillary cysts are also common in the hilum of the ovary and broad ligament. They have essentially the same structure, being composed of tubular glands lined with columnar or cuneiform epithelium ; and their surface is more or less distinctly papillary. They secrete mucus freely.

Such papillary and adenomatous intra-cystic growths are homologous to warts on the integument.

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[1] See *Catalogue of St. Bartholomew's Hospital Museum*, Nos. 2807 and 2808.

II. Congenital Cysts

Cysts originating in persistent rudiments of fœtal structures and congenital cysts.

1. *Cysts formed in the remains of the Wolffian duct and body in the female.*—These were first systematically described by Dr. Coblentz in Virchow's Archiv, Bd. 5, 1881. In ruminants and some other mammals the whole of the Wolffian body and duct persists. But in the human female only the anterior or sexual portion is normally present; it lies in the broad ligament, being known as the parovarium or organ of Rosenmüller. It consists of twelve or fifteen narrow vertical tubes about half an inch in length, which radiate upwards from the hilum of the ovary to join a horizontal tube running nearly parallel with the Fallopian tube. These vertical tubes represent the anterior or sexual segment of the Wolffian body; a few similar tubes are in rare instances found between these and the uterus, and are remnants of the posterior non-sexual segment. The horizontal tube, known as Gärtner's duct, is the duct of the same organ; it passes from the broad ligament into the side wall of the uterus, down which it courses into the anterior wall of the vagina, where it is usually lost. Wolffian remains also extend into the tissue of the hilum of the ovary, and in horizontal sections of that organ are seen as tortuous rods or columns of epithelium. This portion of the gland is named the paroöphoron; while the ovarian tissue proper is spoken of as the oöphoron.

All remnants of the Wolffian body and its duct give rise by distension to cysts, and the great majority of these according to Doran contain papillary proliferous growths. They are conveniently classified as:—

(*a*) Hilum cysts, which spring from the hilum of the ovary, and are distinguished from cysts of the oöphoron by having a layer of true ovarian tissue spread over their free surface. They often contain papillary intra-cystic growths.

(*b*) Broad ligament cysts.—These arise from the normally persistent vertical tubes or parovarium, and sometimes in Gärtner's duct. The cysts lie between the layers of the broad ligament, which is usually evenly expanded. The Fallopian tube courses over their upper surface, and is much stretched if they attain a large size. They contain a clear watery fluid, but sometimes the contents are discoloured by hæmorrhages. In larger cysts an epithelial lining rarely exists, but in smaller ones columnar or columnar-ciliated epithelium may be found.

2. *Cysts of Müller's duct.*—A small cyst, known as the hydatid of Morgagni, is attached to one of the fimbriæ of the Fallopian tube in the female and to the head of the epididymis in the male. It represents the terminal end of Müller's duct in the female and in the male, but is of no clinical importance.

A remarkable instance of persistence of Müller's duct on one side in its whole length has been described by Dr. Ord. The dilated duct formed an elongated cyst extending from the right kidney to the sinus prostaticus.

3. *Cysts from the urachus.*—Among other rarities, mention may be made of cysts arising in the persistent urachus. Some are lined with ciliated columnar epithelium and others with hair-bearing skin; they may attain a great size. Cases have been observed in which the cyst communicated with the bladder, and this circumstance has given rise to the passage of hairs with the urine when the cyst was dermoid.

Cysts have also been known to develope in Meckel's diverticulum, from the blocking up of the intestinal end.

4. *Dermoid cysts.*—These cysts are found in connection both with skin and mucous membrane and in various internal organs. A dermoid cyst must, therefore, be defined as a cyst lined with skin or with mucous membrane and of congenital origin. They may conveniently be divided into: (*a*) Dermoids derived from epiblast by *enclavement.* (*b*) Dermoids of internal organs.

(*a*) The first group comprises dermoid cysts of the skin, mouth, rectum, and nerve-centres, and those situated near the median line in the thoracic and abdominal cavities. They are all produced by cutting-off of a portion of epiblast (*enclavement*) during the process of closure of branchial fissures, of the body walls in the middle line, and in the formation of the membrane bones of the skull and face. They also occur in connection with the involutions of epiblast to form the mouth, genito-urinary apertures, rectum, the eye and ear, and the brain and spinal cord.

(*b*) The second group include dermoids of the ovary and testis, and perhaps may be attributed to exceptional formative powers and tendencies to variation in the structures from which these organs arise. But since the Wolffian duct has recently been shown to be of epiblastic origin, the possibility suggests itself that these cysts may also be derived from the epiblast.

Distribution.—On the head and face they are more often situated over the lines of sutures. Their commonest site is beneath or near the eyebrow, especially towards the outer side; but they are also found at almost any part of the orbital margin. On the skull they are more often observed on the temple near the fronto-maxillary suture, round the anterior fontanelle and over the mastoid process; but they may exist at any part. On the face they occur over the middle line of the nose, the fronto-nasal suture, and rarely on the cheek. On the neck they are placed laterally, viz., over the parotid gland, near the angle of the jaw and along the anterior margin of the sterno-mastoid at points corresponding to the lines of the first three branchial fissures. Or they are median, being commonest here beneath the hyoid bone (sub-hyoid cyst). Those of the skull and orbital margin are always deeply placed and attached to the periosteum. They often lie in a depression in the bone, which may even be perforated; or the cyst is placed entirely within the skull. In the College of Surgeons' museum is a parietal bone perforated at its centre; from the aperture a dermoid cyst was removed and the patient died of meningitis.

Some dermoids near the angle of the jaw and along the sterno-mastoid have deep connections attaching them to the styloid process and sheath of the carotid vessels.

Cysts formed during the closure of the body walls are observed, especially near the junction of the first and second bones of the sternum and near the umbilicus; also in the thoracic and abdominal cavities and even in the lung itself. In connection with the development of the central nervous system, dermoids occur in the brain and over the spine. They are fairly common over the sacro-coccygeal region, constituting one of the varieties of congenital sacral tumour.

Precisely similar cysts are also generally distributed. I have met with two over the scapula and one near the breast. They exist as rarities in the limbs. Those of the digits are often due to implantation of epithelium by wounds.

The dermoids of the ovaries are situated within the oöphoron ; those of the testicle within the tunica vaginalis, and sometimes are enfolded by the parenchyma of the gland.

Dermoids found in various parts of the abdominal cavity are often of ovarian origin, having become separated by twisting of their pedicles.

Structure.—The dermoid cysts included in group (*a*) are usually simple in structure. They have a lining possessing the microscopic characters of skin, which shows the normal arrangement of the epidermis with papillæ. Some are devoid of both hairs and glands; others are furnished with hairs and sebaceous glands, while in a smaller number the wall also contains sudoriparous ones. The contents are fatty matter of oily, honey-like or buttery character. This is derived from degenerated cast-off epithelium and from the secretion of sebaceous glands. Microscopically it shows epithelium and crystals of margarin and cholesterine. Similar cysts to these form a large proportion of group (*b*), i.e., dermoids of internal organs, not apparently connected with epiblast. Cysts of the same nature as dermoid are found in the floor of the mouth, in the neck and omentum ; they are lined with pavement or with columnar ciliated epithelium, and may conveniently be described as mucoid cysts. I have examined a sublingual cyst from John Hunter's collection of this nature. Some of the cysts of the neck are covered on one side by skin and on the other by mucous membrane, indicating that the lining was derived from the epithelium on each side of a branchial cleft. They may even open externally like a persistent branchial cleft. Complex dermoid tumours occur in the ovary, scrotum, sacro-perineal and maxillary regions, in the thorax and abdomen, and, in one instance, in the orbit. Many of them are included in the group of congenital tumours to which the name of teratomata has been given. They are for the most part cystic, or solid. The cysts are respectively lined in varying proportions with skin and with mucous membrane. Those having an integumental covering present the ordinary features of dermoids ; and in the ovary and elsewhere may contain hair, teeth, nails, and overgrown sebaceous glands, which even reach the complexity of a mammary gland. The cysts are embedded in a stroma of young or of mucoid connective tissue in which may be found in varying frequency plates of bone, cartilage, unstriped and, very rarely, striped muscle, with nervous elements of various kinds, i.e., uni- and multi-polar cells, medullated fibres and fibres of Remak. Further, traces of organs may exist as lungs, intestine, eye and lymphoid tissue. In the sacro-coccygeal and maxillary regions a complete series of transitions between dermoid cysts and parasitic fœtuses has been observed.[1] Bland Sutton has sought to connect the origin of certain simple and complex dermoids with some fœtal canals, as the infundibulum, the hyo-lingual duct and the neuro-enteric passage.

Period of origin.—The nucleus of all dermoids is congenital, with the exception probably of some cysts of the ovary. Cutaneous dermoids do not usually appear till puberty, and this circumstance may be connected with the accelerated activity of the skin, shown by the development of the hair in certain parts.

Dermoid cysts and tumours of the ovary are commonest between fifteen and thirty years of age.

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[1] I have suggested that the complexity of these tumours depends on the period of embryonic life and the extent of the blastoderm involved in the disturbance, the tumour being more complex the earlier the disturbance.

They occasionally become the seat of epithelioma and of sarcoma.

A few instances have been recorded in which dermoid cysts of the ovary have been ruptured, and their contents escaping, have become implanted on the omentum and peritoneum and have given rise to small secondary cysts of the same nature.

5. *Congenital Hygroma.*—These tumours of infancy are most commonly situated on the neck and gluteal region, and less frequently in the axilla, on the arm, thigh, and cheek. Like other cystic tumours, the proportion of solid tissue and cyst varies greatly. The tumour may be chiefly composed of numerous intercommunicating loculi embedded in gelatinous connective tissue, or may be for the most part solid, the cyst-spaces being small and scattered ; exceptionally it is composed of one large cyst. The cavities are loculated, their walls are smooth and rendered irregular by imperfect septa. Their contents are serous fluid, in some instances sanious, rarely creamy and rich in cholesterine. The tumours always lie beneath the deep fascia, and tend to spread widely in an irregular manner between the muscles, even infiltrating their substance. In the neck they occupy the front or lateral aspects ; they are often attached to the sheath of the large vessels and may extend upwards behind the pharynx to the base of the skull, downwards beneath the deep fascia into the thorax, or into the axilla. The loculi and spaces are lined with an endothelium, the borders of which are irregular, but not dentated in the manner peculiar to lymphatic vessels. In some instances, their walls are surrounded by a layer of unstriped muscle-fibre. The stroma in growing portions of the neoplasm has the characters of embryonic connective tissue. When the morbid growth infiltrates muscle or a gland, striped muscle and epithelium may respectively be found in it.

The pathogeny of these tumours is still somewhat doubtful. The form, lining, and nature of the contents of the loculi point to their being a variety of lymphangeioma. They originate at a very early period of intra-uterine life, probably the fourth or fifth month.

Symptoms.—They may merely give rise to inconvenience from their size, but in the neck often cause serious symptoms from pressure on the trachea, the gullet and large vessels.

Treatment.—Tapping may be resorted to with good effect when large cysts exist. Setons have been used for the purpose of setting up suppuration and inducing occlusion of the cysts in that manner. Tincture of iodine may also be injected for the same purpose. But these means are attended with the danger of setting up cellulitis. The safest method is excision. This operation should not be lightly undertaken, since it is attended with much difficulty and danger, owing to the deep expansions of the growth and the displacement and matting together of important structures. Electrolysis has also been employed, but not with satisfactory results.

SOLID TUMOURS

FIBROMATA

Fibromata are tumours composed of adult or well-developed fibrous issue. They form distinctly circumscribed, encapsuled, movable masses, which are either lobulated or uniform in outline. They also occur as pedunculated subcutaneous tumours (molluscum fibrosum) and as polypoid growths from mucous membranes. In consistence, they vary from a density approaching that of cartilage, to a succulent, yielding, but still not friable tissue. Fibromata of the labia majora and pedunculated fibromata of the skin are often extremely succulent, and large quantities of serum exude from them on section; this variety was formally described as the fibro-cellular tumour.

A section of the firmer fibromata displays a number of outstanding fibrous bands on a grey, yellowish, or opaque white ground, or the section is firm, uniform, and dull white. The fibres either interlace, are arranged concentrically, or in parallel lamellæ. A scraping yields no juice. Microscopically the firmer tumours are composed of looser or more compact bundles of fibres, often wavy and interlacing, or disposed chiefly parallel to each other (fig. 6). Situated on the bundles, in small numbers, are flattened nuclei of connective-tissue cells, the protoplasm of which may be demonstrated to anastomose by processes around the bundles. The softer forms are made up of interlacing fibrillæ, more or less thickly studded with large round or oval connective-tissue cells, whose protoplasm is continuous with the fibrillæ.

As varieties fasciculated and lamellar fibromata have been described.

In some of the laminated fibromata, layers of connective tissue are concentrically disposed around blood-vessels and nerves. When a nerve and its branches are involved, as for example, the pes anserinus, a very curious tumour, composed of tortuous anastomosing cylinders (plexiform neurofibroma) of fibrous tissue is formed. The fibrous nodules of cartilaginous density found on the pleura and in the capsule of the spleen are examples of laminated fibromata in which the laminæ are arranged parallel to the surface.

The distribution of the fibromata is exceedingly general, for they occur wherever connective-tissue exists, the following being the chief sites: the skin and subcutaneous tissue, fasciæ, capsules of joints and synovial fringes, the nerves, the nose, gums, the periosteum of the lower jaw, ovary, round ligament, and breast.

Painful Subcutaneous Tubercle.—These tumours are situated in the corium or subcutaneous tissue, are rounded, rarely exceeding half an inch in diameter, and are usually single. They occur with much greater frequency on the lower extremities, and are more common in women than in men. Insignificant in themselves, they attract attention from the severe darting pain to which they give rise, sometimes associated with extreme tenderness. Probably in many cases the pain is much exaggerated by hysteria or allied conditions.

The precise relation of these fibromata to nerves is still a matter of question. Many observers have failed to find any connection with a nerve; while, in other cases, nerve-filaments have been traced into the tumour or found spread out over its surface. And, in certain instances, the whole tumour has been stated to be composed of non-medullated nerve-fibres (Virchow).

A passing allusion may be made to the small fibromata which occasionally form around the punctures for earrings. They are notable from the fact that not rarely they recur after removal, but show no other signs of malignancy.

Fibromata may undergo mucoid metamorphosis and also calcification, the latter change being often observed in those connected with the jaw.

Friction or other forms of irritation may act as exciting causes; in two instances I have observed symmetrically-placed fibromata over the ligamentum patellæ.

They do not recur after removal, but their relations with the sarcomata are exceedingly close. At times the differentiation between fibroma and fibro-sarcoma is impossible without the microscope. And, again, a fibroma may exist for many years and ultimately develop into a sarcoma.

Diagnosis.—Fibromata are circumscribed, fairly movable, usually smooth, dense, but elastic and heavy. When pendulous and œdematous they are of soft and yielding consistence. Microscopically they exhibit adult fibrous tissue with scanty cells, and at growing points it may be observed that the young cells are forming adult and well-developed fibrous tissue; while in the fibro-sarcomata the cell-elements are abundant and their transformation into fibrous tissue is incomplete.

Lipomata

Lipomata or fatty tumours resemble ordinary adipose tissue, except that the individual vesicles are often of larger size. They are *circumscribed* or *diffused*. The common circumscribed lipoma of the subcutaneous tissue is easily recognised by its lobulated or slightly irregular outline, its mobility, and its elasticity, which often approaches semi-fluctuation. The overlying skin, on being raised, is found to dimple slightly, owing to connective-tissue fasciculi which pass between it and the tumour. This shells out readily from a capsule of condensed connective tissue, and its surface is smooth, but deeply fissured and lobulated.

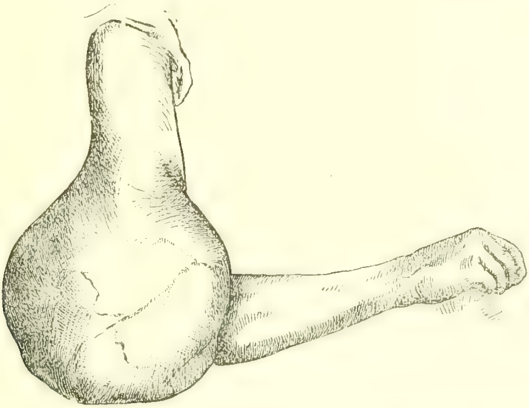

FIG. 3.—Fatty tumour of 37 years' growth on arm of woman, æt. 69.

The trunk and especially the shoulders are the seat of election of lipomata; perhaps, it may be said broadly, the regions of the shoulder and pelvic girdle. But they are sometimes observed on the limbs, and I have seen two cases of multiple lipomata on the arms of women.

They also form between muscular planes, in the tongue, uterus, walls of stomach and intestines, in the scrotum around the tunica vaginalis, in connection with the periosteum of the skull and other bones, and with the sheaths of blood-vessels. Appendices epiploicæ may enlarge and constitute tumours. Masses of fat connected by a pedicle with the peritoneum are also found protruding through the linea alba, and along the inguinal canal into the scrotum, where they simulate omental herniæ.

Age exercises a marked influence on the formation of lipomata; middle life, when adipose tissue is accumulating, being that in which the great majority occur. But cases of congenital lipoma are not very rare. The parts affected chiefly are the sacro-coccygeal region, perineum, neck and back; and the formation of fat may be associated with congenital hypertrophy.

Mechanical irritants, as carrying weights on the shoulder and back, are exciting causes; and it would appear in such cases that an irritative new formation of connective tissue undergoes fatty transformation.

Degenerations.—Lipomata undergo softening or oily change; and, in tumours of long standing, the connective-tissue septa may become calcified. Very large and, especially, pendulous tumours are subject to ulceration of the dependent skin, perhaps followed by sloughing and suppuration.

An extensive formation of fat is exceptionally associated with myxomatous or sarcomatous peri-renal tumours—lipomatous myxoma. True lipomata are, of course, essentially innocent; but they tend to grow continuously. The diagnosis is usually obvious from the physical characters of the tumour, its seat, and the age of the patient.

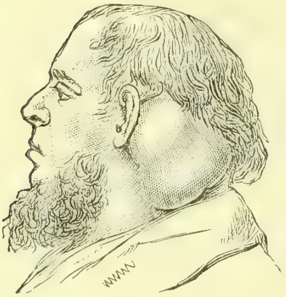

Fig. 4.—Diffused lipoma of neck.

Diffuse lipoma constitutes, as its name implies, a non-circumscribed doughy mass, usually forming a collar around the neck, and composed of separate masses; one of these projects from the nape, another from each parotid region, and another hangs beneath the chin like a dewlap. Or such a mass may be present in any one of these regions without the others being affected. The subjects of this peculiar growth are usually obese, and often addicted to immoderate use of alcohol. Brodie recommended for it large doses of liquor potassæ.

MYXOMATA

Myxomata are new formations of loose, fibrillar connective tissue, permeated with fluid which is rich in mucin. The physiological prototype of these growths is found in Wharton's jelly of the umbilical cord. The commoner examples of pure myxoma are pedunculated, as the polypi of the nose, rectum, and some polypi of the uterus. Their dependent position and narrow pedicles favour œdema. This may to some extent, but probably does not entirely account for their succulence; for in nasal polypi cysts are found evidently resulting from mucoid transformation of their substance. Pure myxomata also occur in the subcutaneous tissue, beneath the periosteum, and in the nerves, constituting one variety of neuroma.

A section exhibits a glistening, pale, jelly-like tissue, the surface of which is raised in the centre. Microscopically, the neoplasm is composed of stellate and round cells, of which the protoplasm is prolonged in delicate filaments forming a felting of fibrils (see fig. 5). The stellate cells are chiefly characteristic of mucous connective-tissue; in some growths they exist exclusively, while in others the round cells preponderate. The vessels are usually abundant and clearly seen, owing to the transparency of the tissue; they often form a wide meshwork.

Pure myxomata do not recur if completely removed, but in the large majority of so-called myxomata, the mucous is mingled with sarcomatous tissue. These growths are described farther on as myxo-sarcomata.

The diagnosis, except when the tumour is deeply seated, is patent from the appearance, consistence, and seat of the growth.

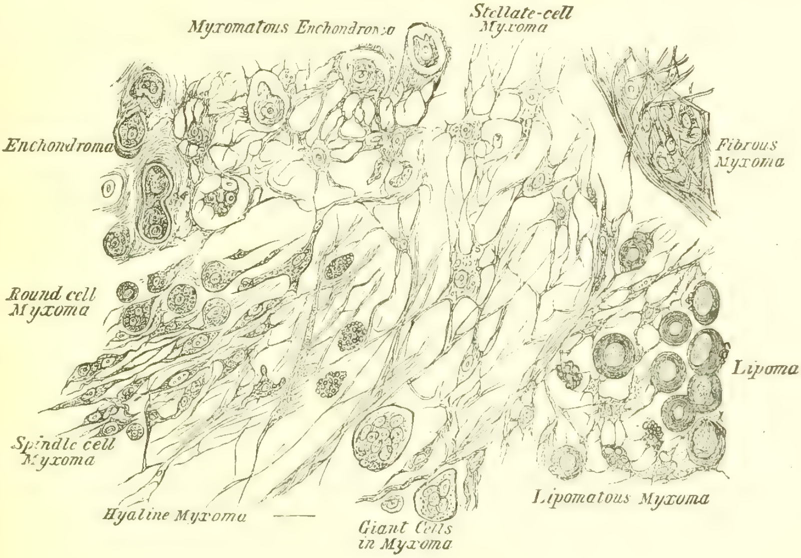

FIG. 5.

ENCHONDROMATA

Enchondromata are tumours composed of cartilage, chiefly of the hyaline variety. They present well-marked physical characters. Their surface is nodulated and uneven, extremely firm to the touch, but not rarely there are soft points produced by mucoid degeneration. The section is glistening, smooth, and translucent, and almost invariably shows a number of separate masses or lobes divided by bands of connective tissue containing blood-vessels. These bands are often continuous with the membranous capsule constituting the perichondrium. In other cases, the section is often greatly modified by secondary changes.

Microscopically, the commoner forms have practically the same structure as ordinary hyaline cartilage. In many the cartilage cells are more irregularly distributed, and more numerous in proportion to the matrix ; the capsules are larger, and in growing parts of tumours a single capsule often contains two or more cells. The cells at the periphery beneath the perichondrium are flattened. Not rarely stellate ones are observed, especially in the parotid tumours, when the cartilage is produced by chondrification of connective tissue. But such cells are also observed in tumours of bone ; for example, of the fingers. Fibro-enchondromata, i.e., growths with a fibrous matrix, occasionally occur (fig. 6).

The degenerations of chondromata are important, owing to the way in which they modify the physical characters. Mucoid metamorphosis produces liquefaction of the matrix and the formation of cysts, so that the whole mass of a large tumour may be converted into a large cavity surrounded by a thin wall of cartilage; or the whole tumour may be rendered uniformly soft and diffluent. The opposite condition may result from calcification and ossification, which begin in the centre of the tumour; or, if it spring from a bone, from the parts adjoining the wall. The process of calcification consists simply in the deposition of lime-salts in the matrix and cells; while in ossification the cartilage is converted into true bone. In the latter the cells proliferate, their capsules enlarge and open into each other, blood-vessels penetrate into the mass of young cells thus formed, and trabeculæ of bone are then developed around the vessels. In some instances the matrix of enchondromata is extensively converted into connective tissue. Cartilage cells are also prone to undergo fatty degeneration, a change obvious to the naked eye by the appearance of ochre-yellow patches.

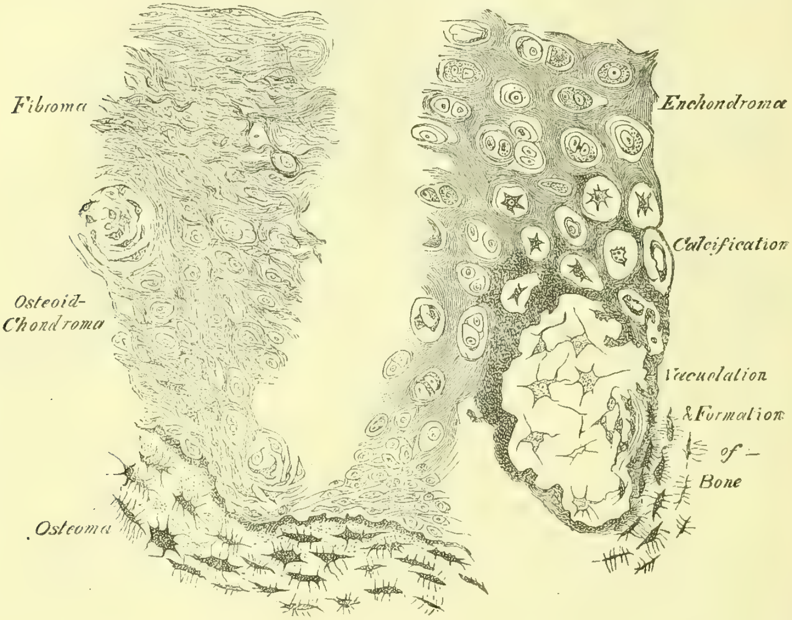

FIG. 6.

The distribution of enchondromata is very wide; they occur most commonly in the bones, in glands, as the parotid, the testicle and breast, and in the subcutaneous tissue. Any bone may be affected, but the digits of the hand most frequently; next in frequence—the lower end of the femur, the head of the tibia, the humerus, and the great toe. Among other bones less liable to these growths may be named the base of the skull, vertebræ, ribs, pelvic bones, lower jaw, and scapula. Enchondromata of the digits merit a special notice. They are nearly always multiple, originate in infancy or early life, and grow into large nodulated masses around the digits and metacarpal bones, with great deformity of the hand. Their increase ceases with that of the skeleton generally; and in such cases heredity may often be traced. They spring from the medullary cavity and expand the bone or burst through its wall at one point and then envelop it. Their source is probably from small masses of primordial cartilage which were not removed in the formation of the medullary cavity, but remained quiescent for a time, and ultimately took on active growth. Enchondromata at the ends of the long bones—as the femur—are usually sub-periosteal and in all probability originate from portions of the growing epiphysial disc, which in like manner remained unossified. Tumours of the shafts of the long bones usually surround them more or less completely, but are often connected with a mass in the medullary cavity, which may indicate that they have sometimes the same mode of origin as those of the digits.

The cartilage occurring in parotid tumours is formed by the chondrification of the connective-tissue stroma. These neoplasms are usually largely composed of myxomatous tissue, which, in morbid growths, is often associated with cartilage. Pure enchondromata occur in the testicle ; but in the majority of cases the cartilage is combined with sarcoma-tissue (chondrosarcoma). In fact, the sarcomatous granulation tissue is, in part, directly transformed into cartilage. Secondary tumours, under these conditions, are formed in the lymphatic glands, lungs, &c., likewise largely composed of cartilage. Hence it was that some enchondromata were formerly believed to be malignant. It is scarcely necessary to add that pure enchondromata are innocent.

The diagnosis is usually clear ; the chief factors are the situation of the tumour, its slow growth, its extreme hardness, weight, and its nodulated surface.

OSTEOMATA

Of these there are three varieties : the *eburnated*, *compact*, and *cancellous*. The eburnated have no prototype in the normal skeleton, except, perhaps, in osteo-dentine. They occur as small flat elevations or bosses on the surface of the skull, and are histologically peculiar in having no Haversian canals, the small, flattened lacunæ being arranged in lines parallel to the surface. Eburnated osseous growths, usually described as diffuse osteomata, also spring from the bones of the face ; they form irregular ivory-like masses, filling the frontal sinuses, growing from the orbit, especially near its margin, or involving the whole superior maxilla. I know of two instances of tumours of this description, springing from the orbit, in which the skin ulcerated, the osseous mass protruded, and ultimately was shed like an antler.

Compact osteomata are observed on the shafts of the long bones, with which their structure is identical (fig. 6). They sometimes form slightly raised overhanging masses with a wide base of attachment to the bone.

The name cancellous sufficiently describes the structure of the third variety, the most common and widely distributed of all. With rare exceptions they are situated on the diaphyses of the long bones, near to, but not necessarily over, the epiphysial disc ; and are covered with a layer of cartilage, the deeper surface of which grows continuously and is converted into bone. This fact, and their situation, leave no room for doubting that they originate from aberrant portions of the epiphysial disc which have not been converted into bone. Genetically they are therefore closely allied to the enchondromata of bones. I have observed that such exostoses are more common in rickety subjects. At times they are multiple, affecting all the long bones of the skeleton; and in such cases, like the multiple enchondromata, they cease to increase in size after the completion of growth. A marked hereditary tendency often exists. The distal phalanx of the great toe beneath the nail is a common site for exostoses.

These osteomata should not be confounded with exostoses formed by ossification of the attachments of tendons and muscles—such as occur in connection with the adductor magnus, the psoas and iliacus, or the deltoid.

Lastly, osteomata are in rare instances found altogether unconnected with bone,—in the subcutaneous tissues, for example, of the buttock or thigh.

Masses of bone are also formed in the gracilis and deltoid muscles; but these can hardly be considered as true tumours, being, perhaps, the result of inflammation or over-use. Those which occur in the adductor longus are known as 'rider's-bone,' because they are met with in cavalry soldiers and rough-riders.

MYO-FIBROMATA

Myo-fibromata, as the name implies, are composed of muscle and fibrous tissue, in varying proportions. The muscle presents the ordinary characters of the unstriped or involuntary variety, and is distributed in interlacing fasciculi. The outline of individual fibres often is not easily distinguishable in sections, but the fibres may be readily isolated by teasing after hardening in chromic acid. In some growths of long duration the fibrous tissue preponderates. The naked-eye characters resemble those of a coarse fibroma, the section being marked by distinct interlacing fibrous bundles. The growth is well-defined, and can usually be enucleated without difficulty.

Degeneration—either mucoid, fatty, or calcareous—is not uncommon; and patches of softening or collections of serum, forming cysts, may develop within them. They occur in almost all structures containing unstriped muscle; with great frequency in the uterus; in the œsophagus, intestine, bladder, testicle, ovary, round ligament, and in the prostate, in which they constitute the chief portion of the common enlargement of that organ. Their growth is slow, and clinically they are benign. Spindle-celled sarcoma, which also occurs occasionally in the uterus, can often only be distinguished with great difficulty from myo-fibroma.

ANGEIOMA

Under this name are included nævi, cavernous tumours, and aneurysm by anastomosis.

Nævi, or 'mother's marks,' are tumours composed of convolutions of dilated capillaries lying in the corium and subcutaneous tissues. They are always congenital, and at birth may exist as a tiny red or purplish speck, which spreads more or less rapidly. As a rule, the growth is exceedingly slow, and it may be questioned if, in a large number of cases, the increase much exceeds that of the surface of the skin. Their fate, if left alone, has not been carefully studied: some shrink and wither, others appear to become warty, papillated and deeply pigmented. In one case which I observed a nævus of the ear developed into an aneurysm by anastomosis. Superficial nævi—those, that is to say, that involve the corium—appear as bright red, or purple, and slightly raised patches. Deeper ones, lying subcutaneously, form rounded, rather ill-defined, doughy, or spongy tumours, which diminish in size on pressure, and communicate a bluish tint to the superjacent skin. Many nævi involve both skin and subcutaneous tissue. The superficial form is usually described as a capillary, the deeper as a venous or cavernous nævus: but no distinction as regards their minute structure can be drawn between them; both are made up of tortuous anastomosing capillaries, usually only moderately dilated. A section through a subcutaneous, or so-called venous or cavernous, nævus exhibits a number of whitish, firm, fat-like lobules, united by connective tissue, showing to the naked eye few indications of its real structure. In rare instances the capillaries become so much dilated as to form cavernous sinuses, but this is certainly the exception.[1] The capillaries of nævi are lined with a layer of plump endothelium, and bounded with a thin lamina of connective tissue; they are usually closely approximated and are supported by connective-tissue trabeculæ rich in nuclei. Hair-follicles, sebaceous and sudoriparous glands are interspersed.

The treatment of these growths is detailed elsewhere.

Cavernous angeiomata are met with in the liver, kidneys, and in the walls of the intestines; in a leg which I dissected numerous cavernous tumours were situated along the course of the large veins. They are composed of large venous sinuses separated by narrow connective-tissue trabeculæ. Aneurysms by anastomosis are rare and are usually situated on the scalp. They have an expansile pulsation, and their surface is irregular from the projection of tortuous dilated arteries. One, which I injected and examined, involved the whole pinna of a young woman, and was entirely composed of a very delicate netlike anastomosis of minute arterioles.

LYMPHANGEIOMATA

These are to the lymphatic vessels what nævi are to the blood-vessels, and like the latter are congenital. Tumours composed solely of dilated tortuous lymphatic channels have been described, but usually fibrous hypertrophy of the affected part is associated with many dilated and tortuous lymphatics, as for example in macroglossia. I have observed considerable dilatation of the lymphatics in congenital hypertrophy of the hand and foot.

Congenital hygroma of the neck, as pointed out already, is probably a form of lymphangeioma.

NEUROMA

The great majority of tumours classed under this heading are simple fibromata springing from the peri- or endo-neurium. They are either merely embedded in the nerve-trunk or form nodular thickenings of it; and even individual fasciculi of the trunk may present minute bead-like enlargements. It is not rare to meet with cases in which nearly all the nerve-trunks of the body are studded with fibro-neuromata. Occasionally these neoplasms are associated with molluscum fibrosum of the skin. Rare instances of true neuroma, composed of convoluted bundles of medullated nerve-fibres have been recorded, and Virchow has described tumours composed of delicate threads, which he regarded as amyelitic fibrils. Myxo- and spindle-celled sarcomata also occur in nerve-trunks, and it may be noted that it would be difficult to distinguish histologically the latter from developing nerve-fibres.

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[1] A good example of this is in the Royal College of Surgeons' Museum, No. 407.

SARCOMATA

Sarcomata are tumours derived from the connective-tissue constituents of the body, but their elements never develop into fully formed or adult structures; they are always arrested at some intermediate stage in the formation of the various connective tissues, as fibrous tissue, bone or cartilage. Their elements are, therefore, often described as embryonic, and they are spoken of as embryo-tissue tumours. This name implies a theory which is both misleading and untrue. It is misleading because an inference is apt to be drawn that these tumours originate from embryonic rudiments of connective tissues, whereas by far the majority originate in adult life, and, as far as we know, from adult tissues. It is also untrue because certain sarcomata, as the spindle-celled, have no counterpart in the connective tissues of the healthy embryo. The true prototype of the various forms of sarcoma may be found in the transitions of granulation-cells to form fibrous or scar-tissue and callus, and clinical evidence abounds indicating that many of the sarcomata of later life have an inflammatory or irritative origin. On the other hand many of those observed during the first five years of life may with much probability be referred to an irregularity in or arrest of development.

The sarcomata are divided into three chief varieties, the round-celled, spindle-celled, and myeloid. Between these many intermediate forms are observed; thus, round and spindle-cells may be mingled in nearly equal proportions—*mixed sarcoma ;* and myeloid cells are associated either with round or with spindle-cells. Again the spindle-celled sarcomata shade off indefinitely into the fibromata (see *Fibro-sarcomata*).

Round-celled sarcoma.—These again are divided into two sub-varieties, the small and the large. The former is much the commoner, and its component cells are about the size of leucocytes or granulation-cells. In the latter they are as large as those of squamous epithelium. A section of a round-celled sarcoma under the microscope shows a *uniform* surface formed of closely crowded cells, perhaps intersected here and there by a band of connective tissue. In this respect and the character of the cell it differs essentially from cancer. The nuclei are large and the protoplasm around them scanty, in fact many of the small round-celled tumours appear to be composed almost entirely of nuclei, in many of which evidence of nucleus-division (karyokinesis) may be demonstrated with appropriate reagents. The intercellular substance varies ; it is usually scanty and homogeneous, sometimes formed of delicate interlacing fibrillæ prolonged from the protoplasm of the cells, and sometimes of homogeneous bands. The blood-vessels are usually abundant, and in many instances have no proper wall. They are lined with rounded endothelium which rests directly upon the cells of the tumour. Hence they often become dilated or rupture and form blood-cysts, which give rise in tumours of bone to pulsatile expansion.

Spindle-celled sarcomata are composed of either small or large spindle-cells analogous to the fibro-blasts of young granulation tissue ; they possess an oval nucleus, and their extremities are prolonged into a more or less delicate fibre. The cells are closely approximated, and are ranged in parallel or intersecting fasciculi or bundles. Many spindle-celled sarcomata show a partial transformation into fibrous tissue. The protoplasm of the cells unites to form a coarse stroma, only the elongated nuclei remaining visible, as may be observed, in many sub-periosteal tumours of bones; or the protoplasm is prolonged into filaments which unite in fasciculi (fibro-sarcomata). Such tumours can only be distinguished from fibromata by the large number of nuclei present, the imperfect development of the fibrous tissue, their succulence and relatively rapid growth.

Myeloid Sarcomata occur almost exclusively as *central* tumours of bones —rarely sub-periosteal—and in the gum as epulis. They are characterised by the presence of irregular multi-nucleated masses of granular protoplasm (giant-cells) the physiological prototype of which is the osteoclast. They are associated either with round or spindle cells, or both, and transitions from the round to giant-cells may be observed (fig. 7). A section has, in parts or over the whole surface, a peculiar maroon-red tint, by which the nature of the tumour may be recognised.

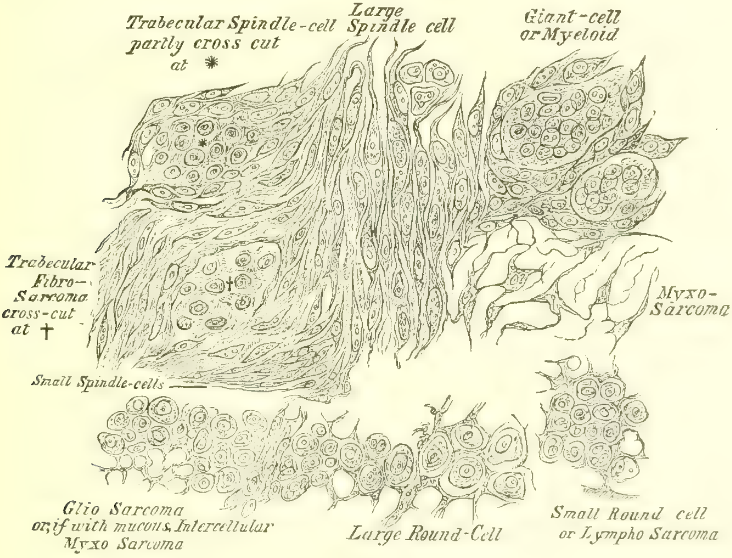

Trabecular Spindle-cell partly cross cut at *
Large Spindle cell
Giant-cell or Myeloid
Trabecular Fibro-Sarcoma cross-cut at †
Myxo-Sarcoma
Small Spindle-cells
Glio Sarcoma or, if with mucous Intercellular Myxo Sarcoma
Large Round-Cell
Small Round cell or Lympho Sarcoma

FIG. 7.—Sarcoma.

Many sarcomata of bone undergo partial transformation into cartilaginous or osseous material. In the former (chondro-sarcoma) the intercellular substance is abundant and hyaline, and becomes chondrified. The latter (calcifying or osteo-sarcomata) are composed either of round or spindle cells. The round cells are enclosed each in a mesh of a delicate fibrous reticulum in which lime-salts are deposited. The process is analogous to the calcification of the imperfectly formed fibrillar matrix of bone sometimes observed in rickets, and in callus. In osteo-sarcoma the secondary growths in lymphatic glands and internal organs are also calcified.

Myxo-Sarcoma.—Some tumours of the breast, parotid gland, testicle, and rarely of the periosteum, have a white, translucent, gelatinous aspect due to mucoid metamorphosis. Under the microscope they show, in varying proportions, branched and round cells, which stand out distinctly in an abundant homogeneous stroma (fig. 7). Only a portion of the growth may have undergone this change, the remainder being composed of ordinary round or spindle-celled tissue.

Alveolar Sarcoma is another sub-variety, clinically unimportant, and is found in bone, muscle, and subcutaneous tissue. The cells are large, round, and not unlike epithelium; they form either small masses in alveoli, bounded by delicate bands of fibrous tissue; or, more often, each cell is enclosed in a mesh of a fibrous network.

Melanotic Sarcoma.—These present characteristics pathologically and clinically midway between the sarcomata and cancers. They, for the most part, originate in moles of the skin and in the choroid of the eye, and have also been observed on the vulva, hard palate, and growing from the matrix of the nails. They are extremely common in white horses. In colour they are black or sepia-brown; and a section may be pigmented uniformly or only in small parts, the remainder resembling medulla. Histologically they usually have a more or less marked alveolar structure, the stroma being scanty. The cells in cutaneous tumours are round or irregular from pressure, often of large size, and may have an epithelial aspect; they are sometimes mingled with spindle cells. The tumours of the choroid are commonly composed of spindle cells.

The pigment is deposited in granules within the cells; and, to a smaller extent, lies free in the stroma.

Individual cases of melanotic sarcoma vary greatly in malignancy. In the majority, the prognosis is exceedingly bad. Shortly after the appearance of the tumour, small, pigmented, secondary nodules are seen in neighbouring parts of the skin, and the nearest lymphatic glands become affected, the growth sometimes extending directly in lines along the lymphatic channels. Within a brief space dissemination takes place in internal organs, the liver being a favourite site for them; and, in some instances, the skin over the whole body is dotted with the growths. On the other hand, melanotic tumours, having the same general appearances, may grow slowly, and not recur even after a tardy removal.

From the foregoing account it may be noted that the melanotic sarcomata of the skin closely approach the cancers, in that they possess an alveolar structure, often an epithelioid type of cell, and in the fact that they originate in connection with a structure—the skin (itself pigmented)—derived from epiblast. And further, as in cancers, the lymphatic glands are early affected. It may subsequently be shown that those attributed to the choroid really spring from the pigmentary layer of the retina, which is also of epiblastic origin.

I have myself observed in two instances melanotic tumours continuous with tap-like ingrowths of the epidermis, as in epithelioma; and for these reasons am impelled to believe that these tumours are really, in many instances, cancers originating in patches of imperfectly developed skin, such as moles.

Simple, circumscribed, melanotic masses.—A very remarkable and rare disease has been described under this name, in which innumerable, well-defined masses of black pigment are formed simultaneously in many organs and structures. The primary focus of infection often cannot be ascertained. The nodules vary in dimension from a microscopic grain to the size of an egg or fist, and are observed in the subcutaneous tissue, peritoneum, breast, and in the muscular substance of the heart. The pigment-granules constituting the masses accumulate in the cells of the normal tissues, namely, in the connective-tissue cells, muscular fibres, and epithelium; these are destroyed, and the tissues are replaced by a nodule, or a tumour softened at the centre, there being no trace of a cellular new-formation, such as exists in melanotic sarcoma and cancer. The disease in man proves fatal in a few months; whilst in horses, in which it is common, its progress is slow.

Lympho-sarcoma.—This must not be confounded with lymphadenoma. It is a variety of round-celled sarcoma, originating in a lymphatic gland, extending by contact to a whole group and to neighbouring chains, but never, like lymphadenoma, involving simultaneously the whole lymphatic system. The disease not unfrequently attacks the mediastinal glands, spreads along the bronchi into the lungs, and involves the pericardium. The morbid growth is medullary in character, but rather firm, and yields a milky juice. The microscopic structure presents a rough resemblance to the cortical portion of a lymphatic gland, the chief part consisting of lymphoid cells, arranged in rounded masses or in irregular cylinders lying in the meshes of a coarse, fibrous stroma. A reticulum, such as is found in lymphadenoma, does not exist.

Glioma, or *gliosarcoma*, is a variety of connective-tissue tumour arising from the neuroglia of the brain, retina, and, in rare instances, the spinal cord. It is commonest in the retina of children, and springs probably from the granular layers. Retinal gliomata are composed of small round cells united by a scanty homogeneous or fibrillar intercellular substance. In those of the central nervous system the protoplasm of the cells gives off prolongations, which are continuous with a felting of delicate fibrils.

In the central nervous system these growths appear as white, or pinkish, ill-defined masses, firmer than the surrounding brain-tissue into which they merge insensibly. Usually they are situated in the convolutions, and are solitary, but occasionally multiple. Although they possess the features of local malignancy, they do not give rise to metastasis in distant organs; in this respect, however, glioma of the retina is distinctly worse, being very prone to recur locally.

Myo- or *Rhabdo-Sarcoma.*—Mixed tumours composed of round cells and striped muscle, have been observed in infants or young children. They are adherent to and sometimes infiltrate the substance of the kidney, and in some instances have involved both organs. Similar growths occur in the testicle; and both striped and unstriped muscle not rarely are present in cystic sarcomata of that organ. In the rhabdo-sarcomata the muscle takes the form of transversely striated fibrils, or of elongated spindle-cells, also striated.

Adeno-Sarcoma.—Certain sarcomata of glands, as the breast, parotid, and testicle, contain a variable amount of the normal gland-tissue distributed throughout their substance. The sarcoma-tissue originates in the stroma of the organ, expands and stretches out the gland-tissue, the epithelium of which must therefore grow to cover the increased surface, but otherwise there is probably no new-formation. Certain of the ducts or gland-tubules are obliterated, and the intervening portions may be dilated, and form cysts, into which, in the breast and sometimes the testicle, rounded masses of sarcomatous stroma protrude. Adeno-sarcomata may be made up of almost any form of sarcoma-tissue; but the stroma is commonly composed of round or stellate cells with a large proportion of fibrillar connective tissue (fig. 8).

Cylindroma.—This name is given to peculiar neoplasms of rare occurrence, and mostly sarcomata. Their chief distinguishing feature is the presence of intersecting hyaline bands and cylinders, which are produced either by mucoid degeneration of strands of cells, or by greatly thickened blood-vessels, the sheaths of which have undergone hyaline change. The latter condition is more often observed in cerebral tumours. A somewhat similar appearance is met with in growths of nerve-plexuses, as the pes anserinus, in which the cylinders result from thickening of the endoneurium.

Endotheliomata are growths arising from the endothelial linings of various cavities of the body, and of the blood-vessels. Endothelium being derived from mesoblast and belonging to the connective tissue, these growths must be included in the connective-tissue series.

Psammoma, or *angeiolithic sarcoma*, originates in connection with the membranes of the brain and spinal cord. It is characterised by the presence of spheres, usually calcified, resembling in structure and mode of formation the brain-sand of the choroid plexus. The spheres are united by fibrous tissue, and are sometimes arranged in a dendritic fashion. They are composed of very large and thin endothelial plates, disposed in concentric laminæ, and, according to Cornil and Ranvier, are formed by buds springing from the walls of blood-vessels, which are numerous. Presumably the cells are derived from the endothelium of the blood-vessels. In their clinical character these tumours are innocent.

General characteristics of sarcomata.—Great variations exist in their physical characters. The majority have a well-defined, rounded, and at times a largely nodulated outline; and many are distinctly encapsuled. Some of the softer, round-celled forms infiltrate like cancer. Their consistence includes every grade, from that of soft brain-tissue, or jelly, to that of a fibroma; in colour they are creamy or pearly white, and often blotched with various shades of red, yellow, and brown, produced by changes in extravasated blood. The section is uniform, homogeneous, faintly fibrillar or distinctly fasciculated. Some indication of the structure may be obtained from the naked-eye character. Thus the round-celled growths are usually soft, medullary, or semi-gelatinous; the spindle-celled have a smooth, rather firm, homogeneous section, and a few faint, fibrous bands only can be traced on their surface, or they may be distinctly fascicular. The appearances of some of the special varieties have already been described.

Modifications result from the various forms of degeneration affecting a part or the whole of the mass, *i.e.* mucoid, fatty, or caseous; or from hæmorrhage and cyst-formation. When the skin gives way over a sarcoma it usually protrudes as a red, soft mass of granulation-tissue. The duration, progress, and malignancy of these tumours offer as much diversity as their physical characters. Soft, medullary, rapidly-growing neoplasms, and the melanomata, are the most malignant, sometimes killing, from generalisation of the growth in internal organs, within a few months. At the other extreme the spindle-celled sarcomata of the skin and the fibro-sarcomata grow exceedingly slowly; but they are prone to recur near the cicatrix, again and again after removal, and five or six operations may be performed before the patient succumbs from exhaustion, or dissemination of the growth. Such tumours were formerly described as 'recurrent fibroids.' As regards prognosis, the rapidity of growth, consistence, and locality are of more importance than the microscopic structure. Of this it may broadly be said, that the elementary round, and spindle-celled growths, especially the former, are more malignant than those in which there is an attempt to organise and form fibrous tissue.

Locality is a most important element, sarcomata of the testicle being, for example, much more malignant than those of the breast. Of tumours of bone, the myeloid are by far the least malignant—probably, in great part, because, being usually central, they are enclosed by an osseous capsule.

The mode of generalisation of sarcoma differs essentially from that of cancer; in the former the blood-vessels are numerous, thin-walled, often mere channels in the growth, and thus the conditions are most favourable for the escape of its elements into the veins, whence they are carried into the heart, lungs, and other viscera; while, in the latter, secondary growths first appear in the nearest chain of lymphatic glands, and from these the tumour-elements pass into the blood-stream. But it is erroneous to suppose that the glands are never affected in sarcoma, for in growths of the testicle and tonsil it is the rule (Butlin). Glands are also often involved by contiguity, when the growth originates near them, as in tumours of the ilium. An outgrowth from a sarcoma may project into, and grow for a great distance along, a vein. In a mixed-celled sarcoma of the forearm, I found a prolongation extending for some distance along, and occluding one of the veins at the bend of the elbow.

EPITHELIAL-TISSUE TUMOURS

This large and important group comprises tumours derived from the epithelium of the surfaces and glands of the body; and which, speaking broadly, originate from the epi- or hypo-blast. It need scarcely be remarked that these tumours are composed of both epithelium and connective tissue; in fact, in some, the latter preponderates, as in contracting scirrhus; but it is the epithelium which takes the initiative in growth, and gives to the tumour its special character.

These neoplasms are divided clinically into two groups—the innocent and the malignant. To the former belong papilloma and adenoma, to the latter carcinoma.

PAPILLOMATA

The simplest are merely overgrowths of the normal papillæ of the skin or mucous membrane, each consisting of a central stem of connective tissue, containing capillaries, and covered on the surface by a thickened layer of cuticle, which at the end may be prolonged into a point. Such papillomata occur frequently upon the skin and tongue.

Others are composed of a series of minute outgrowths, subdivided at their tips (compound papilloma). Others again, in the bladder, form branched or dendritic masses, covered with columnar epithelium (villous growths); while those that occur in the ducts of the breast, and in ovarian and parovarian cysts, are more complex still, the interstices between the papillæ being prolonged downwards as glandular tubules.

The external form and consistence necessarily vary very greatly, even in those springing from the same structure. For example, warts; fleshy, vascular verrucæ; and even long, spiral horns—composed of closely-packed cornified papillæ—may appear upon the skin. The cause is usually some irritant, and, therefore, papillomata are often multiple, as in the case of warts on butchers' hands and of the verrucæ which are associated with discharges from the generative organs. In some cases this is so striking that a local infection has been suggested as the cause; and various forms of bacilli, and psorospermiæ have been described in connection with them.

ADENOMATA

Adenomata are hyperplasias of gland-tissue of which the epithelium presents the regular and orderly arrangement, reproduces the general form, and does not overstep the general limits of the gland in which they originate.

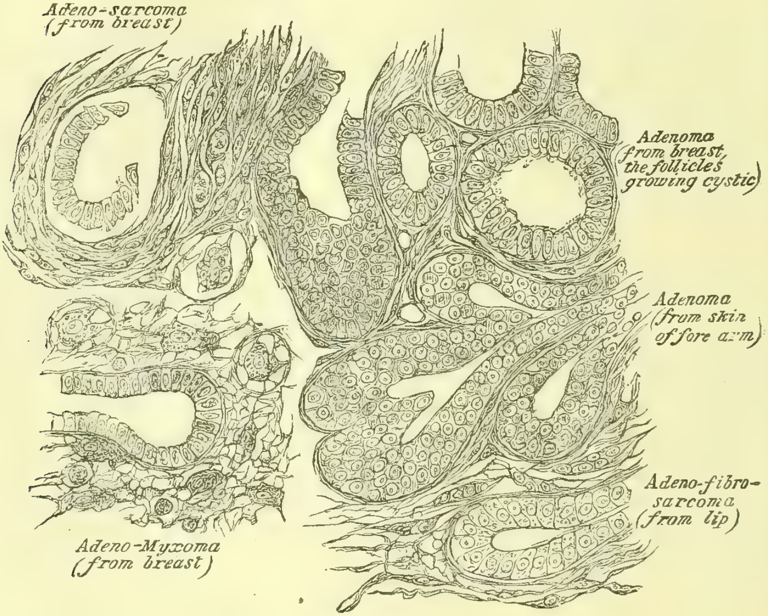

Adeno-sarcoma (from breast)
Adenoma (from breast, the follicles growing cystic)
Adenoma (from skin of fore arm)
Adeno-fibro-sarcoma (from lip)
Adeno-Myxoma (from breast)

FIG. 8.—Adenoma.

Clinically, they are always innocent, but so closely do the so-called adenocarcinomata resemble them histologically, that it is rather by their general characters and limits than by their microscopic structure that they may be distinguished in some instances; for example, the true adenomata of the intestine never pass beyond the mucosa, while the cancers extend through it, penetrate the muscular coat, and even involve adjacent organs. Adenomata are described as tubular, acinous, and follicular, according to the type of gland-tissue. They occur in the breast, intestine, cutaneous glands, ovary, thyroid, parotid, liver, and kidney.

Physical characters.—In the breast and skin they are nodulated, encapsuled, and freely movable; in the uterus and intestine they form polypoid outgrowths; in other organs, as in the ovary, they may involve the entire structure. Cysts are frequently present, being formed either from gland-tubules, or from closed follicles, as in the ovary and thyroid.

Microscopically the simplest form is the common mucous polypus of the rectum, which is composed of tortuous branching tubules lined with a single layer of columnar epithelium, and whose architype is the Lieberkühn's crypt.

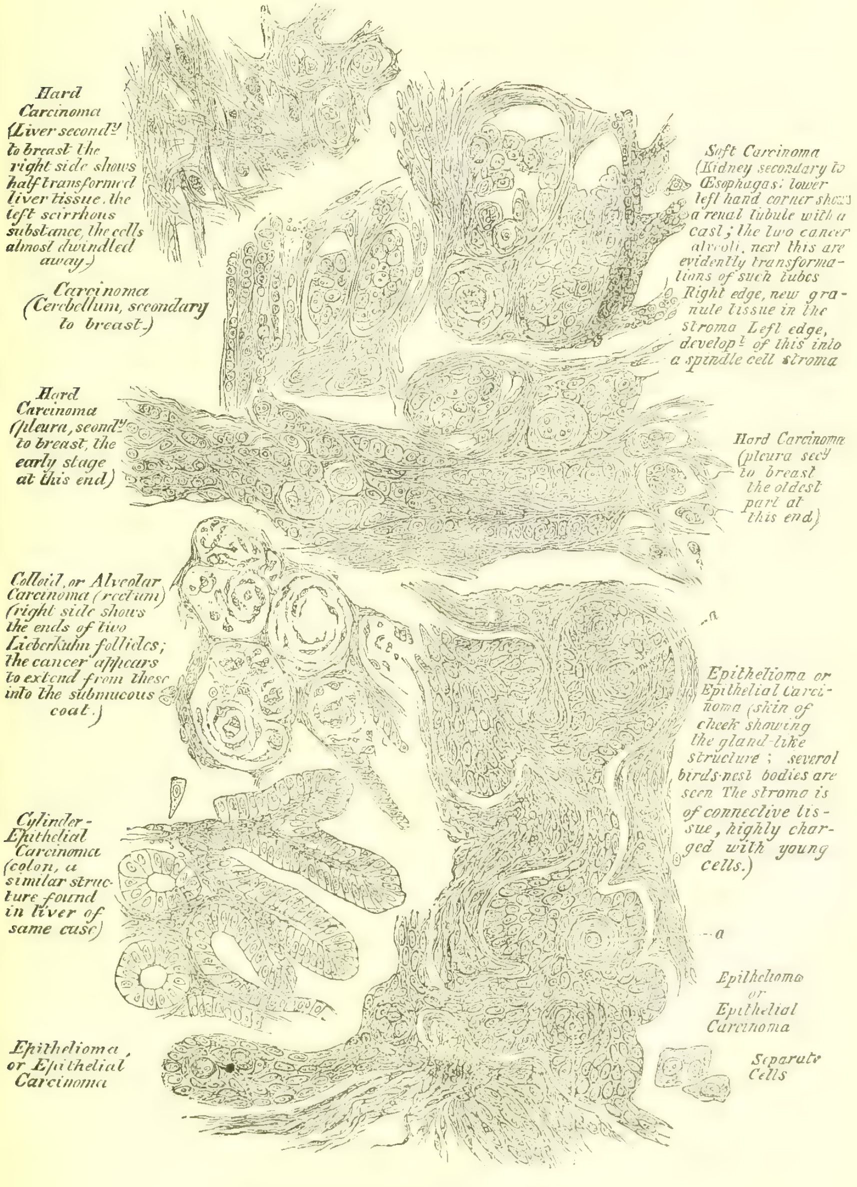

Hard Carcinoma (Liver second^y to breast the right side shows half transformed liver tissue, the left scirrhous substance, the cells almost dwindled away.)
Carcinoma (Cerebellum, secondary to breast.)
Hard Carcinoma (pleura, secnd^y to breast, the early stage at this end)
Colloid, or Alveolar Carcinoma (rectum) (right side shows the ends of two Lieberkühn follicles; the cancer appears to extend from these into the submucous coat.)
Cylinder-Epithelial Carcinoma (colon, a similar structure found in liver of same case)
Epithelioma, or Epithelial Carcinoma
Soft Carcinoma (Kidney secondary to Œsophagus: lower left hand corner shows a renal tubule with a cast; the two cancer alveoli, next this are evidently transformations of such tubes Right edge, new granule tissue in the stroma Left edge, develop^t of this into a spindle cell stroma
Hard Carcinoma (pleura sec^y to breast the oldest part at this end)
a
Epithelioma or Epithelial Carcinoma (skin of cheek showing the gland-like structure; several birds-nest bodies are seen The stroma is of connective tissue, highly charged with young cells.)
a
Epithelioma or Epithelial Carcinoma
Separate Cells

FIG. 9.—Carcinoma. (*a*) Cell-nests.

The stroma is soft, œdematous, and made up of a fibrillar tissue with stellate and round cells. The common statement that adenomata do not secrete is erroneous, for the tubules of rectal polypi pour out quantities of mucus, and many ‘ goblet cells ’ may always be observed ; and in a specimen of fibro-adenoma of the breast, removed soon after lactation, I found a quantity of milk which exuded from the section. In fibro-adenoma of the breast, the gland-tissue takes the form of elongated, curved, narrow *cul-de-sacs*, probably elongated acini, or of ducts cut across or terminating in trefoil-shaped alveoli. The new formation of gland-tissue is often inconsiderable, and it would appear as if that of a mammary lobule were merely stretched out and deformed by a growth of connective tissue.

Cutaneous adenomata are of two kinds, the sudoriparous and sebaceous. The former are composed of tortuous columns of small spherical epithelium ; the latter of gland-tissue of an acinous type, the acini being filled with fatty matter and epithelial cells. Both form freely movable, firm tumours, having a lobulated structure, and they are prone to undergo calcareous degeneration. The sebaceous adenomata are usually situated on the scalp.

CARCINOMA

Carcinomata are overgrowths of the epithelial linings and glands of the body, which spread indefinitely by infiltration through contiguous structures, and are prone to affect early the lymphatic glands by transference of their elements along the lymph-channels. Those originating in glands offer an irregular, disordered, and rudimentary resemblance to the mother gland ; sometimes it is closer, but the likeness is never so exact as in the adenomata, the arrangement of the cells being less regular, with no attempt at the formation of a basement membrane. Some of the clinical differences have already been alluded to.

Cancers are divided anatomically into groups, in accordance with the nature of their epithelium.

Squamous epithelioma, for example, springs from the stratified epithelium of the skin and mucous membrane ; *cylindrical-celled*, from the columnar epithelium of the mucous tracts and glands ; and *spheroidal-celled*, from that which lines secreting structures in the breast, kidney, testicle, &c.

Squamous-celled epitheliomata.—These form flattened, superficial, or more deeply infiltrating growths on surfaces lined by squamous or transitional epithelium. They often spring from a crack or papilloma, an old ulcer, a scar, or a patch of epithelium thickened by long-standing inflammation.

The superficial outgrowth or hypertrophy of epithelium constituting a wart or papilloma is sometimes followed by an ingrowth of the deeper layers, as, for example, in chimney-sweep's cancer. However arising, the earliest change is an elongation of the inter-papillary processes of epithelium, and an infiltration of the corium or mucosa with leucocytes. The processes continue to grow downwards as tap or finger-like prolongations, and soon are studded with cell-nests ; finally, the normal boundary between the epithelium and sub-epithelial connective tissue is broken down, and the growing cells are merged in the subjacent connective tissue, which is infiltrated with leucocytes. The epithelioma may then be said to be definitely formed. The growth now extends in the direction of least resistance, namely, along the connective-tissue interspaces ; and nuclei are carried with the lymph-stream into the lymphatics. A general infiltration or injection of the connective tissue interspaces and lymphatics results, composed of tortuous columns and rounded masses of epithelium. In epitheliomata of the tongue, skin, and some other parts, the central cells of the tap-like prolongations from the surface and of the deeper masses, become cornified, so that a transverse section shows a number of concentric laminæ bounded by a layer of epithelium, like the rete mucosum. These are the epidermic globes, cell-nests, or birds'-nests. But other smaller concentric whorls are interspersed irregularly thoroughout the growth, and perhaps may more strictly be termed cell-nests; they are much smaller than the epidermic globes, and are composed of a few plump, central cells, undergoing proliferation, surrounded by two or three layers of small, flattened cells (fig. 9).

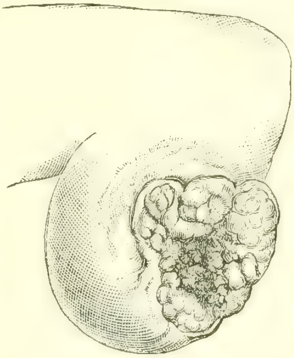


FIG. 10.—Epithelioma of stump, of two years' standing, from a man, æt. 58.

Ulceration usually occurs through breaking down of the superficial portions of the neoplasm. The surface of the ulcer, whether it fungates or is excavated, is surrounded by a raised, hardened, often sinuous edge, and its base is indurated in proportion to the depth of the infiltration. At times the surface is papillary, or is covered with thickened epithelium as in growths on the heel; and even an extensive epithelioma of the tongue may present no ulceration. The lymphatic glands are involved very early in the disease, and if left alone its duration may be only a matter of months. Death supervenes from exhaustion, consequent on the local effects of the disease, and from cachexia, resulting from secondary growths in internal organs.

The chief seats of epithelioma are the junctions of skin and mucous membrane—as the lower lip, anus, and vaginal orifice; parts especially exposed to irritation, as the tongue; various parts of the skin, the glans penis, the palate, posterior wall of larynx, vocal cords, œsophagus, cervix uteri, and urinary bladder. In the latter organ it often produces soft papillary or vegetative outgrowths.

Rodent ulcer, rodent epithelioma, cancroid of the skin.—These names are given to an exceedingly chronic, slowly-growing form of epithelioma affecting the upper part of the face of people advanced in years. Its favourite sites are the external canthus, the side of the nose, and temple. The disease first appears as a slight thickening of the skin, which spreads as a flattened, slightly-raised, superficial nodule, of which the centre becomes abraded. An ulcer results, having a smooth, dry, pinkish-red surface, which spreads, with a slightly-raised, rounded, firm border. Exceptionally, the centre of the nodule remains smooth, pale, and cicatricial, while the growth continues to extend at its periphery.

Histologically, rodent epithelioma is made up of rounded or lobulated masses of very small, round, or slightly flattened cells, usually invading only the corium. Cell-nests with cornification are absent, except occasionally in the thickened superficial epithelium covering the edges. In sections of growths before ulceration has taken place, the epidermis sometimes forms an unbroken layer, and has no connection with the underlying characteristic neoplasm. The sebaceous glands in the neighbourhood are enlarged, undergoing transformation into the small-celled growth, in which the sheaths of the hair-follicles are also involved. There can, therefore, be no question that this peculiar neoplasm springs from the sebaceous glands and hair-sheaths, and not from the epithelium of the surface. It is placed above the convolutions of the sudoriparous glands. The disease may exist for years, producing by its extent great disfigurement, and even destroying the bones of the skull and face ; but it never implicates the glands. There is a great tendency to local recurrence after removal.

Cylindrical-celled cancer, or epithelioma, is the common form of morbid growth met with in the alimentary canal, from the cardiac orifice of the stomach to an inch above the anus ; below this point squamous-celled epithelioma occurs. It is also observed in the mucous membrane of the body of the uterus and in the bronchial tubes. In minute structure these neoplasms form a more or less close reproduction of gland-tissue after the type of the tubular mucous gland. They are made up of a number of cylinders and alveoli lined with cylindrical epithelium, and result from a growth downwards of the mucous glands into the mucosa. This becomes in consequence greatly thickened and upraised ; subsequently the growth extends through the muscular coat, which on section appears much increased in breadth. So close a likeness in many cases does the new formation bear to gland-tissue, that cylindrical-celled cancer is classed by Continental pathologists of high repute among the adenomata, notwithstanding its malignancy. But in some tumours, not otherwise differing in type, the cells retain the young spheroidal form, and are distributed in solid columns or rounded masses, instead of forming a lining to the alveoli. The naked-eye characters offer a great variety in form and consistence. A large number are firm and cicatricial, and the disease either constitutes a distinct tumour, or in the intestine has the appearance of a limited cicatricial contraction. Some form soft medullary masses fungating into the intestine ; whilst in others ulceration is the prominent feature, adjoining viscera—as the bladder in cases of cancer of the rectum—being often penetrated. Excepting rodent epithelioma, this variety of cancer perhaps exhibits the slowest progress. Secondary deposits are found in the mesenteric glands and in the liver, to which cancerous emboli are carried by the portal veins. The seats of predilection are the cardiac and pyloric orifices, the sigmoid flexure and rectum.

Spheroidal-celled Cancer.—This occurs in the breast, testicle, ovary, nose, and palate. The common cancer of the breast may be taken as an example. This takes the form either of a general infiltration of the gland, or of a nodule, the physical characters of which are detailed elsewhere. The earlier stages which I have studied in chronic mammary indurations do not differ essentially from those of epithelioma. The first step is the proliferation of the epithelium lining the ducts and acini. These become choked and the surrounding tissue thickly infiltrated with leucocytes. Next the epithelium breaks through the basement membrane and grows into the connective-tissue interspaces, where the bulk of the neoplasm is formed. As a rule the true gland-tissue has already undergone atrophy. A reactive new-formation of connective tissue follows the inroads of the epithelium. If dense fibrous tissue is formed in abundance, the tumour is hard and scirrhous ; if the connective tissue is soft and small in quantity, it is medullary. Between these extremes every grade may be observed. The amount and distribution of the epithelium offer corresponding variations. In scirrhus it is scanty, the cells are small and arranged in elongated groups (alveoli), between the broad fibrous bundles. In softer tumours the cells are large, often coalescent, and arranged in long chains and columns, or in large rounded masses. Rare examples are met with in which a closer likeness to gland-tissue exists, owing to the arrangement of the cells in the form of a lining to the alveoli.

The clinical terms hard or scirrhous, soft or medullary, have lost their pathological significance; the difference depends on the relative amount of the stroma and epithelium respectively.

Cancers undergo fatty, mucoid, and colloid metamorphosis. The fatty change is common in cancers of the breast, and in squamous-celled epitheliomata, from a section of which worm-like masses of fatty epithelium may be expressed. Colloid metamorphosis (colloid carcinoma) occurs in growths of the stomach, intestines, ovary, thyroid, and rarely in the breast. In this change drops of colloid material appear in the protoplasm of the epithelium, pressing the nucleus to one side and distending the cell in the form of a vesicle. The cell-wall gives way, and the cells merge together in a gelatinous mass. In the alimentary canal these often constitute exuberant outgrowths, which on section exhibit to the naked eye large alveoli bounded by thin bands of stroma, and containing soft, white, jelly-like material.

Cancers of the breast more commonly undergo mucoid metamorphosis, which attacks the stroma. The epithelium is unaltered, and the alveoli are bounded by broad transparent hyaline bands of connective tissue. A section presents a uniform, moderately firm, gelatinous aspect. Such growths are described as carcinoma myxomatodes.

The chief characteristics, common to all cancers, are as follows:—they form infiltrations which spread indefinitely without any sign of boundary or capsule. On section a reticulated or alveolar appearance may usually be distinguished with the naked eye. Their alveolar structure is marked under the microscope, a condition not met with in any other form of malignant tumour except the alveolar and melanotic sarcomata. A scraping of the surface yields a milky juice. This cannot be obtained from soft sarcomata until they have been kept about twenty-four hours. Cancerous ulcers resulting from growths in the skin are usually crateriform, with infiltrated edges.

The elements of the disease are carried directly along lymphatic channels to the corresponding group of glands, from which general dissemination by the blood takes place. Among organs commonly the seat of secondary formations are the liver, lungs, heart, adrenals, kidneys, spleen, and the bones. The disease also spreads by contiguity in neighbouring parts and by transference along the lymphatics; thus in a case of contracting scirrhus adherent to the skin—in which there were one or two nodules—an injection of Berlin blue permeated the alveoli of the primary growth and passed into the minute lymphatics of the skin, demonstrating the direct communication of the former with the lymphatic system. The blood-vessels of cancer ramify in the stroma, and capillaries never penetrate between the cells, as in sarcoma.

The largest number of cases occur between the ages of 41 and 50; after that they gradually diminish. A considerable proportion are met with earlier in life, but only ·4 per cent. before the age of 20.

Sarcoma is a disease of an earlier period, and originates for the most part between the ages of 15 and 35.

PART II

GENERAL PATHOLOGY OF INJURIES

CHAPTER I

THE GENERAL EFFECTS OF INJURY

SHOCK

SHOCK is the effect produced upon the nervous system by violent stimulation of peripheral nerves or by mental emotion.

Causes.—These are exciting and predisposing; but the latter are in many instances so important that the distinction between them can hardly be maintained.

The immediate cause is usually the excessive stimulation of a number of sensory nerves, as in extensive burns or when a limb is crushed; but the seat of injury, the mode of infliction, the surrounding conditions, the age, sex, and temperament of the patient, and particularly the amount of blood lost, are of very great importance.

Injuries of the abdomen, urethra, and testis are especially liable to be followed by shock. The effect of a blow upon the epigastrium, of the passage of a catheter, and of violent squeezing of the testis, is well known; the most typical examples are produced in this way, and sometimes they are so severe as to prove fatal.

Concussion of the brain may be regarded as a form of shock, modified by the predominance of certain special and local effects. Division of the cord in castration; section of the bone in amputations; blows upon the cardiac region; and, still more, injuries to the heart itself, are not uncommonly followed by a very severe description.

Loss of blood, if sudden, may of itself cause the most severe shock, and in all cases is a very grave addition. Exposure to cold during operations renders a patient especially liable to it, particularly when ether is used. Mental emotion is of the highest importance; of itself it is sufficient to produce a fatal result, and in all cases it is a very powerful element. In railway accidents, for example, and in earthquakes, shock is especially severe; it may cause death without any discoverable lesion, and not only immediately from intense emotion, but later, after some days or weeks, from gradual failure of power. The nervous system is so profoundly affected that it is unable to recover itself; one single stimulus has left upon it an overpowering impression.

Those who are worried and anxious suffer more severely than others, and nothing is more disastrous than the conviction that an operation will be fatal. On the other hand, in great excitement, or intense mental preoccupation, not only shock, but even pain is not felt, at least for the time. Afterwards, owing to exhaustion, reaction is usually more severe.

In children the element of mental emotion is much less prominent, and unless there has been severe hæmorrhage or prolonged exposure to cold (both of which they stand very badly), they suffer much less than adults. Probably too, this is one of the reasons why the shock in amputations for disease is so much less than it is in a primary operation. Old people are usually affected very slightly; but when it does occur in them it is very grave.

No pathological lesion has ever been found; even the condition of the heart is not constant, although it is usually flaccid and relaxed. The change is essentially a molecular one; the energy of the active tissues, especially the nerves and muscles, suffers the most extreme depression; they are incapable of putting out any force, or of producing the amount of heat requisite to maintain the temperature of the body; the power of doing work of any kind is lost.

Those are most liable to suffer from it whose nervous system is already in what must be called, for want of a better term, a state of depression, whether this is due to natural temperament, or to cold, exposure, fatigue, violent emotion, loss of blood, or other accidental conditions.

Symptoms.—Two varieties of shock are described, the one characterised by extreme depression, the other, which is much the more rare, by great excitement. Upon what the difference depends, why one form should occur and not the other, is not known.

In the ordinary form the patient lies perfectly quiet with the eyelids half-closed, and the limbs in the position that chance may have placed them; conscious, but paying no attention to anything around; able to speak feebly and slowly, but entirely incapable of any mental effort. The face has lost all expression; the skin is cold, pale, and clammy, that on the forehead often being covered with perspiration; the pulse is frequent, generally more or less irregular; the artery seems to collapse and empty itself between each beat; the respiration is shallow, and the temperature far below normal —sometimes as much as three or four degrees. The sphincter ani is usually relaxed; urine, if the bladder is full at the time of the accident, is retained; but afterwards, for many hours, the secretion stops almost altogether.

In the worst cases, such as are almost certain to prove fatal, there is complete absence of the sense of pain. I have many times seen patients dreamily looking on, without a sign of intelligence, while broken fragments of bone were being removed, and search made for bleeding arteries in limbs that had been crushed in a railway accident.

Vomiting is of frequent occurrence; in head injuries it not uncommonly marks the onset of reaction, and in a few moments the face becomes flushed and the pulse regains its vigour and fulness. In other cases it may either occur at the commencement, when it is of comparatively little significance, or later, after a few hours, and then it not uncommonly marks the beginning of the end.

Shock may be almost instantaneously fatal; I have known death occur within five minutes from puncturing a small hydatid cyst in the liver; or it may begin more gradually, and slowly become worse and worse until death ends the scene.

The other variety, that which is characterised by furious excitement, is more uncommon. Its onset is nearly always gradual; at the first there is some ground for hope, and the general condition appears not altogether unsatisfactory, although the pulse is very rapid and devoid of power; very soon, however, the patient becomes restless and begins to talk volubly and incoherently; delirium sets in; the limbs are thrown wildly about, utterly regardless of pain; and in a short time this is followed by a condition resembling furious mania. The result is invariably fatal, from collapse.

Diagnosis.—Syncope due to failure of the blood-supply of the brain rarely causes any difficulty; with hæmorrhage, especially when it is internal, it is different. In many cases of injury to the abdominal viscera it is practically impossible to make a diagnosis, the two are so often associated. Given a case of severe contusion followed by collapse, it may be due to shock alone, or to shock complicated by hæmorrhage from rupture of the viscera, or tearing of a mesenteric artery or vein, and there is no certain method of separating one condition from the other. Failure of sight due to anæmia of the retina; constant yawning or deep sighing inspirations; and throwing the arms about over the head, are very suggestive of hæmorrhage, but nothing more; and a great deal of blood may collect in the abdominal cavity without causing any marked degree of dulness.

Prognosis.—The condition of the pulse and the temperature together give the best clue (always provided there is no hæmorrhage); but a great deal depends upon the kind of injury. Shock may prove fatal almost instantaneously; or it may be very severe at first, and gradually pass off; or, especially after extensive injuries, it may steadily grow worse and worse until at length the pulse fails completely. The maniacal form is nearly always fatal.

Whether an operation should ever be performed during the continuance of shock is a question that depends upon the injury. So far as primary amputations are concerned, I am sure that the best course to follow is to stop the hæmorrhage, prevent decomposition by wrapping up the limb in a strong solution of corrosive sublimate (1 part in 500), and leave it, not until reaction is beginning, but until it has thoroughly set in; and this may not be for more than forty-eight hours. It is impossible at first to say whether the patient will live or not; when in this condition an operation will almost certainly prove fatal. Even when reaction is commencing, the same result is highly probable. I have on more than one occasion seen a patient's face suddenly change and felt the skin grow cold again as the bone was being sawn through; while if the hæmorrhage is stayed and decomposition prevented (as it can be in nearly every case), the patient at least can come to no harm.

The exception to this is where it is necessary to perform an operation, such as opening the abdomen, for the arrest of hæmorrhage. This must, of course, be done at once.

Ether is the anæsthetic usually recommended for operations in these cases; but chloroform is as safe if given in very small quantities; a patient suffering from shock is already almost insensible to pain and requires very little to produce complete anæsthesia.

Treatment.—Hæmorrhage must, of course, be stopped at once; crushed limbs rarely bleed from the large vessels, but often there is a considerable amount of general oozing, which is serious in such a condition as this. Very hot water (with corrosive sublimate), and afterwards firm bandaging, is the most satisfactory method. The elastic tourniquet should not be used, as it is liable to cause sloughing. Where a mass of muscle projects from the end of a crushed stump and persists in oozing, it may be ligatured and cut away.

Warmth is the first essential—hot blankets round the patient, and hot bottles outside these. Stimulants are usually required, but they must be given in very small quantities, at intervals of half an hour, and careful watch must be kept upon the condition of the pulse; as it improves the intervals can be lengthened. If there is much sickness a larger amount may be injected into the rectum. Subcutaneous injections are sometimes resorted to when the patient is insensible and an immediate effect is desired. Ether perhaps acts more rapidly than brandy, but its effect is more evanescent. In many cases ammonia may be given with advantage, either with the brandy (liq. ammoniæ aromat. ʒj.) or even, if the heart is certainly failing, hypodermically, by intravenous injection, as in cases of snake-bite.

Strychnia, digitalis, and other drugs from which much was expected, have all proved fallacious; a very small quantity of morphia ($\frac{1}{8}$ gr.), locally, is beneficial, relieving the pain, and so diminishing one cause of the depression.

Transfusion with blood or with a saline solution is of very little use, if any, in shock uncomplicated with hæmorrhage. Possibly a certain amount of benefit may be derived from raising the limbs, surrounding them with cotton-wool, and then bandaging them so as to diminish as far as possible the area over which the blood in the body has to be distributed.

Delirium Tremens

Delirium of various kinds is met with after injuries. Sometimes it is due to the anæsthetic, or to prolonged exhaustion and exposure, just as occasionally it occurs during the convalescence from protracted fevers; in other cases fat-embolism or the absorption of some poison from the surface of a wound may be the cause; but the best defined and the most characteristic is that which is the result wholly, or in great measure, of alcoholism.

Delirium tremens may occur without injury of any kind, but, as met with in surgical wards, it usually follows an accident, often one of a very trivial character, two or three days after it has been inflicted. Sometimes it can be traced to a prolonged debauch; but it is more frequent in those who, like many brewers' draymen, if they are never wholly sober, are never positively drunk.

The first night is passed in comparative peace, although the patient may not sleep. Next morning the tongue is white, flabby, marked by the teeth, and exceedingly tremulous; the face is flushed and anxious, the hands are strangely restless, the patient seems unable to control them, or even direct their actions; every movement is attended with characteristic tremor; the appetite is lost; the skin is cool, and often moist; the bowels are confined, and generally there is a tendency to nausea. Towards evening the symptoms grow worse: the pulse becomes very rapid, wanting in volume, and frequently dicrotic; hallucinations, often of the most disgusting character, make their appearance; the patient yields easily to control, but only for the moment; the same idea returns again and again, it may be the sight or the sound of something that fills him with apprehension, or it may be something utterly unintelligible, referring in an indistinct way to his occupation; at the same time there is the most ceaseless movement; the hands are never still, aimlessly turning the bedclothes over and over, in a curious, objectless, tremulous manner; the patient lies down, starts up, turns round, looks behind, beneath, above him, anywhere, and does anything but remain quiet for one single instant. Sleep is out of the question. There is rarely any violence; almost always, if spoken to gently and firmly, he will lie down; but it is utterly beyond his power to remain in the same position, and all the while there is the most extreme terror, the horror of something unknown, not to be described.

In this way the night is passed; with morning the symptoms subside in a measure, although they do not disappear. The exhaustion is greater; the pulse feebler, the appetite absolutely lost, and although the hallucinations are not so prominent, the nausea, tremor, sleeplessness and restlessness persist. The forehead is bathed with perspiration, and the temperature is nearly always subnormal; in exceptional cases (which are invariably fatal), it rises rapidly in a way that is only paralleled in tetanus and injuries of the central nervous system.

If sleep returns the following evening all usually ends well, and the symptoms gradually become less and less severe; but if the patient's constitution is already wrecked by prolonged intemperance, or if the injury is a severe one, and sleep does not follow, the prognosis becomes very grave; the prostration becomes more marked; the pulse assumes a running character, the beats being scarcely distinguishable and the volume exceedingly small, the respiration becomes shallow and hurried, the skin is pale and dusky, the face cyanosed and wet with perspiration, and the strength fails rapidly towards the end.

The prognosis, if the patient is seen for the first time, must be very guarded, the condition of the pulse is the best guide; but the age, the state of the kidneys, and especially the extent of the injury, require very careful consideration.

Treatment.—Sleep and food are the chief requisites. If a good night's rest can be secured, or if the patient can be induced to take a fair amount of food, recovery may reasonably be looked forward to. Usually, in these cases, there is severe chronic gastritis; no food has been taken for several days, and even for longer periods, and the appetite is completely lost. Strong beef-tea, with abundance of cayenne-pepper, sometimes answers when nothing else will; milk, with eggs beaten up, is even better, if the patient can be induced to swallow it; but often either he will take nothing at all, or only such things as, from their extreme pungency or acidity, will stimulate a depraved appetite.

Bromide of potash is sometimes given in very large doses, but without much avail; chloral is decidedly dangerous, as it tends to increase the vascular depression; opium, or, better, morphia injected hypodermically, deserves more reliance. One-third of a grain given in the afternoon, before the symptoms attain their full severity, and followed by a second similar dose in the evening, is often effectual; but care must be taken to obtain and examine some of the urine first. If this does not succeed, and the sleeplessness still persists, the head may be shaved, and cold water (half-a-dozen jugs full) poured over it; or chloroform may be cautiously tried, the patient being kept under its influence for twenty minutes or half an hour. If these measures fail, if the patient will not eat and cannot sleep, and particularly if, from the condition of his kidneys, it is not advisable to administer opium, there is no alternative but to give stimulants. If the pulse is a running one, and they are not given, the patient will almost certainly die. In the vast majority of cases there is no doubt it is better to cut them off at once (though it is quite possible it makes the patient worse for the time), but I have seen many instances in which I am sure the free use of stimulants saved life. The best is bottled stout, of the heaviest and sleepiest description, and it should be given freely, without stint, until either the pulse changes its character, or the patient falls asleep.

The bowels should be opened as soon as possible; the liver is almost always congested, and it may become necessary to administer nutrient enemata. Quinine and bitter tonics, or alkalies, with carbonate of ammonia, may be advisable for the gastritis and to improve the appetite; tincture of capsicum is said to be of especial use; but large doses of digitalis are too dangerous.

In many surgical cases restraint of some kind is absolutely necessary, but wherever it is possible, anything of the nature of a strait-waistcoat should be avoided. Of itself it is sufficient to induce delirium and a severe degree of fever. Patients who are suffering from delirium tremens are for the most part very easily controlled, so long as the attendant is firm; and it is only in cases of extreme violence, or when there is a fracture which it is absolutely essential to keep quiet, that any tight restraining appliance is advisable.

TRAUMATIC DELIRIUM

Traumatic delirium, in the strict sense of that term—excluding, that is to say, the delirium due to pyrexia, that which occasionally follows an anæsthetic, delirium tremens, and those forms which are caused by the absorption of poisonous alkaloids—is decidedly rare. Sometimes, however, a kind of delirium attributable to nothing else is met with, especially in old people; although, as it is more usual after fractures, it is possible that the symptoms are due, in a measure, to fat-embolism.

The delirium is not like that of delirium tremens; it has not the same restless busy character, and the hallucinations are not of the same disgusting description. The patient is often exceedingly suspicious, imagining that everyone is wishing to injure him; but when left to himself he remains quiet, watching everything perhaps, and his movements are not tremulous. The tongue is often furred and white, but it can be protruded without fibrillar contractions; food is taken readily; and though the patient's sleep may be disturbed, there is not the same distressing insomnia. Usually the symptoms subside of themselves in the course of a day or two, with a moderate supply of stimulants; but it sometimes happens that they persist, and the mental disturbance is permanent.

TRAUMATIC FEVER

Every kind of fever that follows injuries has been described under this name; strictly, it should be limited to that which results from them directly, and should be clearly separated from those which are due to septic decomposition and other secondary changes. Two varieties may be distinguished—the one caused by nervous irritation; the other by the absorption of certain substances from the interior of the wound.

(A) The neurotic form sets in almost at once, reaches its maximum within the first five or six hours, and then begins to subside again. Irritation of peripheral nerves, pain, mental emotion, and perhaps other causes appear to possess the power of increasing the production of heat, possibly by inhibiting the controlling influence of the heat-centre. In excitable children, and occasionally in women, the mere sight of the preparations for dressing a wound, the knowledge that the time for it has come, or even the apprehension of an operation, is sufficient to raise the temperature as much as two degrees. The same causes, acting with greater intensity, or under different circumstances, give rise to shock, a condition of general depression affecting the whole of the central nervous system.

(B) The other variety, that which is caused by the absorption of certain substances from the interior of the wound, sets in more slowly, and continues so long as there is anything to be absorbed. It is probably due to some of the products that are set free during the coagulation of the blood, as it has been shown that the injection of fibrin ferment can excite pyrexia, and that the height to which the temperature rises is to a certain extent dependent upon the amount of the extravasation. At the same time, other substances set free from crushed and bruised tissues may have some influence; and the tension which is always present in the case of large extravasations may help, partly by its effect upon the nerves, partly by the way in which it assists absorption. As a rule, the fever subsides in the course of forty-eight hours, but it may last a week or more; the temperature, which is of a remittent character, steadily falling after the first day.

CHAPTER II

LOCAL EFFECTS OF INJURY

INJURIES are divided into two classes, subcutaneous and open, as the latter are liable to complications from which the former are practically exempt.

1. SUBCUTANEOUS INJURIES

Simple contusions only are dealt with here; injuries of special structures, bones, ligaments, nerves, arteries, &c., are reserved for more minute description.

Contusions are caused by blows from some hard, blunt object, or by violent squeezes. Blood may be extravasated into the skin, but the surface is not broken; that constitutes an open wound at once. The soft parts beneath sustain the brunt of the violence: the connective tissue with its delicate vessels first; then the muscles, which may be crushed or torn; veins, lymphatics, and, to a less extent, owing to their elasticity, arteries come next; while nerves, as a rule, resist, however much they are stretched.

Contusions vary in degree from a trivial bruise to absolute crushing of everything. Clinically, the number and size of the vessels torn are the most important features. In the slightest form—a wheal, for example, produced by the lash of a whip—there is no bruising perceptible, merely redness and swelling, with local pain, which soon subsides. If it is more severe, a certain degree of ecchymosis follows; some of the capillaries are ruptured; blood is effused into the skin or the subcutaneous tissue; and, according to the structure of the part and the violence of the injury, swelling and discoloration make their appearance. In the worst cases, in which a large vessel has given way, or in which the tissues are soft and easily torn, the amount of extravasation may be enormous; the skin may be separated from the deep fascia of a limb by a layer of fluid blood extending over an immense surface; the scrotum or the loose cellular tissue of the female genitals may be swollen to an enormous size; the tunica vaginalis, the popliteal space, or even the peritoneal cavity may be filled; and the case may prove fatal almost at once from hæmorrhage alone.

A circumscribed swelling in the connective tissue is called a *hæmatoma*: usually it can be recognised at once by its soft fluid centre and its hard and firm margin. When the blood collects in some internal space it is known as a *hæmatocele*. *Cephalhæmatoma* occurs upon the head, either in the subaponeurotic or the subperiosteal layer of the scalp.

The blood pours out until the tension of the extravasation is equal to that at the orifice of the ruptured vessel; then coagulation sets in; and after a variable time the clot breaks down, forming a thick turbid fluid, darker than blood, but still reddening when exposed to air.

The subsequent changes depend upon the amount of the extravasation, the tension, the nutrition of the tissues around, and the way in which the injured part is treated. *Absorption* is the rule; the red corpuscles and the fibrin break down; the hæmoglobin is set free and soaks into the loose cellular tissue; the fluid serum is carried off by the lymphatics; and, when the amount is only small, the white blood-corpuscles wander away. If the extravasation is a large one, the leucocytes in the centre, too far separated from the living tissues, share the fate of the red ones. Finally, the hæmoglobin is removed, and all traces of the injury disappear.

In other cases, however, absorption is not so perfect; a certain degree of *organisation* makes its appearance round the margin, lymph is poured out by the tissues near, and a layer of granulation-tissue, which may become fibrous or even bony, is developed around it. When this takes place, the colouring matter disappears; the fluid in the centre grows paler and paler; and at length the blood-clot becomes converted into a cyst or, more frequently, a thickened rigid layer of dense fibrous tissue without any central space. After a time this too disappears, probably undergoing fatty degeneration and absorption.

Finally, if the tension is high (as when a large artery gives way), or the part is not kept at rest, or the tissues round are so badly nourished that they are unable to stand even the slight irritation of the extravasated blood, inflammation sets in; and then, unless speedy steps are taken to prevent it, *suppuration* is very likely to follow, the pyogenic organisms finding their way to the injured part, either through the blood-vessels, or, if blebs form upon the surface and the epidermis gives way, directly through the tissues.

No material suits them better than extravasated blood, especially if the tissues round are injured by tension, or are not kept at rest. Hæmatomata in the wall of the thorax and between the muscles of the abdominal wall seem peculiarly liable to break down; the cephalhæmatoma of infancy never does.

Signs of Contusions

The degree of swelling naturally varies with the amount and situation of the extravasation and the looseness of the tissues. Pain, unless a nerve-trunk is struck, chiefly depends upon the tension. In some instances—when, for example, the testis is squeezed or the abdomen struck—the shock is very severe. If a large vessel is torn the loss of blood may prove fatal at once, and even if it falls short of this, the hæmorrhage is often exceedingly serious. The staining, if the bruise is superficial, soon shows itself; when it is deep it may not appear for weeks, and then in some far-distant part; rupture of one of the deep veins of the calf, for example, causes discoloration behind the internal malleolus, and in the palm of the hand leads to peculiar purple crescents at the angles between the fingers. The colour varies in the same way: under the conjunctiva it is a bright red; in the loose tissues of the eyelids, black; where the skin is thicker, it is blue or green; and when the extravasation is very deep it is yellow. As the stain dies out it passes through the same changes.

Traumatic fever is very general, and, in the case of large extravasations, not unfrequently severe for several days.

If the bruise is superficial, the skin over it becomes hot and red, owing to the increased vascularity of all the tissues round; more blood flows through the vessels, because there is more work to be done, and a greater amount of repair is required. Provided the part is kept at rest this soon subsides; but if the tension is not relieved, or if any fresh injury is inflicted, inflammation sets in; the swelling continues to increase; the pain becomes more severe; the skin becomes shiny, perhaps œdematous; and then there is every prospect of suppuration.

Treatment.—Slight contusions are best treated with cold or evaporating lotions; lead lotion is especially useful if there is any redness of the skin. Arnica should not be employed at all; its merit is due to the spirit the tincture contains, and it often causes an eruption. Where the extravasation is considerable, uniform, gentle compression, with many layers of cotton-wool, checks the increase, limits the hyperæmia, and promotes absorption better than anything else. Even when the epidermis is lifted up, and bullæ are forming upon the skin, nothing answers better. The fluid should be drawn off through a minute puncture, and absorbed with cotton-wool or thick blotting-paper, the epidermis carefully replaced, a little iodoform dusted on, or collodion painted over, and then cotton-wool carefully applied.

In very severe cases, where there is risk of suppuration, aspiration often averts the danger; there is no need to empty the cavity, removing a small portion of the fluid relieves the tension; the hyperæmia begins to diminish at once, the skin loses its shiny, glazed appearance, and absorption proceeds unchecked. Of course, if a large artery has given way in one of the limbs, so that the collateral circulation is interrupted, and the part below is cold and œdematous, other measures are required.

Occasionally it happens that the contusion of the skin has been so severe as to kill it; if the extent is only small and the deeper structures are not badly injured, the slough should be allowed to separate of itself, and the resulting wound will soon close; but where, as in railway and tramcar accidents, the skin has been stripped off from the subcutaneous tissue for some distance above the apparent seat of injury, and it is thought advisable to amputate, the line of incision must be carried well above, or the flaps are sure to slough.

2. OPEN WOUNDS

Injuries in which the skin (or the mucous membrane) has given way, so that the deeper structures are exposed to the air.

Wounds are described as *incised*, when inflicted with a sharp, clean-cutting instrument; *lacerated* when the parts are torn; *contused* when they are bruised; and *punctured* when caused by the thrust of a pointed weapon. *Poisoned* wounds, in which there is more than the simple division of the tissues, must be treated by themselves.

Incised wounds.—In these the injury is limited, on either side there is only a thin layer of tissue the vitality of which has been destroyed. The symptoms are *pain*, from division of the nerves and exposure of the divided ends to the air; *bleeding*, from the vessels that are cut, varying in proportion to their size and importance; and *gaping*, owing to the elasticity of the tissues. Skin retracts more than anything else, especially when the wound is transverse (except in such situations as the palm of the hand, where it is bound down much too tightly); arteries, if they are simply wounded, bleed most persistently, as the wound is held widely open; if they are completely divided, they shrink together and retract, so that their ends can hardly be seen, and the amount of bleeding, except in the case of the larger ones, is comparatively inconsiderable; veins retract less, but unless they are varicose, and hæmorrhage is favoured by position, bleeding is seldom serious from them. Muscles, when cut across, shorten at once, and often continue to shrink for some time. Fibrous tissue and nerves, on the other hand, retract but little; there is no tension upon them.

Contused and lacerated wounds.—The skin and the soft tissues are torn and crushed, and, especially in the former, the injured area is often very much larger than it appears to be. The degree of gaping naturally depends upon the size, depth, and direction of the hurt; the pain is usually of a dull, aching character, not so severe as in the incised kind; and the hæmorrhage is less extensive. Capillary oozing may be present to a considerable degree, but large arteries rarely bleed in contused and lacerated wounds. The inner and middle coats break off at a different level to the outer one, and they curl up together inside the sheath, so that sometimes not even a drop escapes. An arm may be torn off at the shoulder-joint without any loss of blood from the axillary. The fear is that, owing to the amount of dead and dying tissue, decomposition may set in and open up the way for the whole series of septic processes.

Punctured wounds.—These are caused by stabs with sharp-pointed instruments, such as bayonets and rapiers. The chief dangers are the very serious and concealed injuries that may be sustained by deep-lying structures, such as important vessels and viscera, and the fact that such wounds are nearly always valvular, so that proper drainage is impossible. Punctured wounds, as a rule, either heal at once, or lead to prolonged, deep-seated, and dangerous suppuration.

Repair of Wounds.

Wounds in all cases are repaired by the formation of lymph, which first becomes vascular and then developes into a kind of fibrous tissue. Subsequently, where special structures are concerned, such as bone or muscle, further development may take place. If the amount of exudation poured out is very small, the wound is described as healing by the *first intention*; if there is a considerable quantity, as when a cavity has to be filled up, union is said to take place by the *second intention*. Immediate union, which has been described in the tongues of animals after incised wounds, is merely a variety of the former, characterised by possessing the minimum of lymph; union by the third intention and healing under a scab are only modifications of the latter.

The changes that occur after the infliction of a simple uncomplicated wound do not differ in the least from those that follow a sprain or contusion, or any other form of subcutaneous injury. The hæmorrhage ceases, partly from pressure, partly from the coagulation of the blood and contraction of the torn and bruised capillaries; all the blood-vessels round the injured area dilate, more blood flows through the part (so that the edges of the wound, if it is on the skin, become swollen and slightly reddened), more plasma pours out through their walls, and the cut surface on either side becomes infiltrated with leucocytes and coagulating fibrin. At first, shortly after its infliction, all the separate structures can be distinctly recognised in the wound; in an hour or two they become blurred, the interstices between them and the surface over them are filled with the exudation, or, as it used to be described, the wound is glazed.

If now the two surfaces are brought into apposition, and no irritant of any kind is allowed to injure them, they cohere and become glued so closely to each other, that even after twenty-four hours it is almost impossible to be certain as to the line. This is *union by the first intention.* The lymph that unites the surfaces becomes organised, fresh vessels form from the old ones on either side, fibroblasts gradually range themselves along them, the cells and fibres that have been killed by the accident, and the small quantity of extravasated blood still left in the wound, are absorbed and carried off by the leucocytes, and soon a very thin, delicate layer of vascular, newly-formed fibrous tissue, is all that can be seen of the lymph that filled the wound.

Meanwhile, the surface becomes covered with epidermis by the budding of the living cells on either side, and if the injury is inspected twenty-four hours after it has been inflicted, a faint, red, and slightly swollen line is all that is left. As organisation proceeds, even this becomes less distinct; many of the new vessels disappear, and gradually the colour fades until it is as pale as the parts around. There is no inflammation after a single, simple injury such as this; the changes are identical with those that occur after a bruise, in which the extravasation has not been sufficiently great to cause any tension; there is no loss of tissue, except that which is killed in the original hurt, and the only changes that take place are the ordinary ones that are going on every day; the sole difference is in their rapidity and energy; there is a greater amount of wear and tear than usual, and the process of repair is carried on with greater energy.

When the injury is more severe than this—when, for example, a definite portion of tissue is destroyed or lost—the process is exactly the same, always provided that no fresh irritant appears upon the scene. Suppose, for example, a cavity is left by the excision of a tumour, the surfaces of the wound not admitting of absolutely accurate adjustment. As before, the blood pours out, coagulation takes place, hæmorrhage ceases, and all the vessels round dilate. As before, lymph pours out through their walls, and the leucocytes pervade everything—the softened and swollen tissues on either side of the wound, the little fragments of dead material that are left clinging to them, and the extravasation of blood that fills the cavity. In this case, the amount of lymph thrown out is much greater, there is much more *débris* to be removed, and a greater amount of repair required; but gradually it is all done, and as the vessels grow into the exudation from the dilated capillaries round, the whole wound is filled from all sides and from below with newly-formed, vascular lymph, so-called granulation-tissue. This is *union by the second intention*, and it only differs from union by the first intention in the amount of lymph thrown out. There is no inflammation or suppuration, and there is no loss of tissue other than that caused by the original injury.

The mere presence of extravasated blood (always provided there is no tension and that it does not undergo decomposition) does not prevent union by the first intention, although it delays it; there is a greater amount of dead material to be absorbed, and naturally the process is slower, exactly as it takes longer to repair the effect of an extensive contusion than that of a slight one. And the same may be said of tissue-débris: a certain amount of tissue is killed in every wound; this is removed slowly and quietly by the leucocytes, which literally eat their way into it; the larger it is, the longer it takes, but so long as it does not cause tension or lead to decomposition, union by the first intention is the rule. The pedicle of an ovarian tumour, or a stump of omentum strangulated as tightly as possible and returned into the abdominal cavity does not interfere with immediate recovery; the lymph poured out by the tissues round it is able to deal satisfactorily with it.

Healing under a scab is the same thing. Supposing the cavity, instead of being deeply buried, involved the surface, the blood that pours out from the injured vessels, and the lymph that transudes through their walls, coagulate and form upon the top, where they are exposed to the air, a coating which grows harder and drier the longer it lasts. Under this the lymph becomes vascular, as before, and if at any time the scab is removed, a smooth, pale, glazed surface is exposed, consisting of myriads of leucocytes, traversed by capillaries, and gradually becoming organised, the deeper ones into fibrous tissue, the superficial ones, where they are in contact with the already existing epidermis or epithelium, into flattened cells of the same character. If the scab is detached before the surface is sound all over, a peculiar transformation occurs: instead of remaining flat the topmost layer of the lymph is raised up in the course of an hour or two into myriads of little points, each consisting of a capillary loop, covered with a layer of leucocytes; in other words, it assumes the typical character of granulation-tissue; as soon as the restraining influence of the scab is removed, the newly formed vessels, the walls of which are exceedingly delicate, yield to the influence of the blood pressure, and stretch rapidly upwards in the direction of least resistance, raising up with them a little covering of leucocytes, so that the whole surface appears granular. When this occurs, the superficial layers generally melt away as pus; but this is not essential, and must be regarded as a complication due to the incidence of pyogenic organisms.

If two surfaces, granulating in this manner and perfectly clean, are brought together and held in accurate apposition, the granulations fuse, vessels pass from one to the other, and union soon becomes firm. This is sometimes known as *union by the third intention*; it is chiefly of service in plastic surgery, or after extensive scalp wounds, in which the ordinary treatment has failed.

Cicatrisation

In a simple incised wound, the edges of which are brought together accurately, there is no difficulty in understanding the reproduction of the epithelial or epidermic stratum that covers in the surface; the cells of the rete malpighi proliferate and multiply rather more rapidly than before; while the old stratum corneum is thrown off by the increased exudation beneath, and is quickly reproduced from the growing cells below. The same thing occurs when the extent of surface lost is greater; but the perfection of reproduction becomes less and less the farther the cells lie from the edge of the wound.

If there has been any loss of substance the cavity must first be filled up by the formation of vascular lymph. As soon as this has taken place, or while it is taking place, organisation begins; the deeper layers gradually become converted into cicatricial tissue, and draw the edges of the wound together (in the case of a circular area, in which the contraction takes place from all sides towards the centre, the importance of this in connection with the healing of wounds is easily calculated); the superficial ones, on the other hand, are transformed into epithelium under the influence of the already developed cells at the margin. Without the presence of already existing epithelial or epidermic cells this is impossible; fresh epidermis never makes its appearance spontaneously at a distance from the edge.

The method is the same whether the surface of the lymph is protected from all injurious influences or is exposed freely to the air; but the process is much more rapid in the former, and there is no waste. In the latter, owing to the incidence of the omnipresent pyogenic organisms, suppuration usually occurs; many of the superficial cells are killed and lost as pus; and it is not until the tissues gain the upper hand and are able to resist the attack that organisation begins to make way; then it advances equally from the margin, forming epithelium, and from the sides and base, forming fibrous tissue. By degrees, as the base contracts and the sides skin over, the area over which the pyogenic germs have power is reduced more and more until they are completely shut out. If at any time, before this has happened, some other irritant comes to their aid, healing stops; and, if it is of any intensity, the whole surface of the wound may break down again.

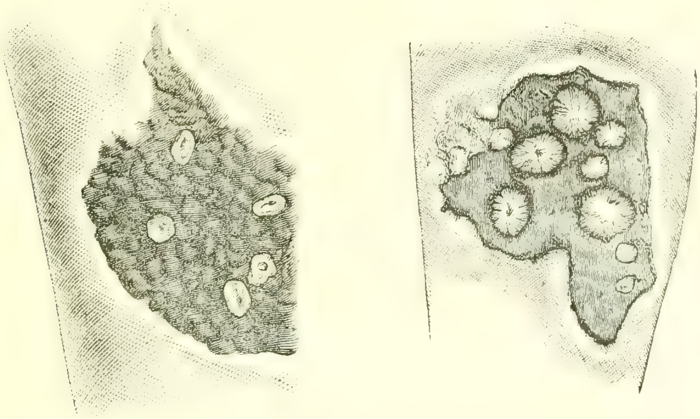
The appearance of a wound as it heals, under these conditions, is very characteristic. If the centre, where repair is not yet complete, has been covered by a perfectly dry scab or by some clean non-adhesive dressing, and this is removed, a pale, smooth, glassy-looking surface is exposed; this is the lymph that has grown up to replace that which has been lost. At the margins it passes imperceptibly into the cicatricial epithelium; the surface seems to become dry; it does not reflect the light so readily; then, a little farther off, its colour changes, becoming rather more blue or purple; and finally, it is plainly and definitely a layer of young epithelium, continuous with that of the skin around. As it grows older it becomes thicker, and allows less of the colour of the parts beneath to show through.

If, on the other hand, instead of being protected and compressed, the centre of the wound is exposed to the air, and suppuration has occurred, the appearance is altogether different. The colour is a bright, florid red; all the vessels are dilated; and the surface is no longer smooth, but covered over with myriads of little points, each corresponding to a capillary loop, which has been stretched out in the direction of least resistance, and has raised up on itself a covering of leucocytes. On this is a little thin pus, formed from the most superficial cells, which have perished; but only sufficient to make the surface moist. Round it, and now seen very conspicuously from the difference of its level and the smoothness and dryness of its surface, is the thin bluish rim of young epithelium, developing exactly as before.

In the case of large granulating surfaces, although repair may advance rapidly at first, after a time progress becomes more and more slow, until often it ceases altogether, whether because further contraction is impossible, or because the infective power of the epithelium is too feeble at the distance. In such cases, which are exceedingly common after burns, an attempt may be made to expedite matters by what is known as grafting.

SKIN-GRAFTING

There are many ways in which this may be performed. The simplest—epidermic grafting—consists in removing minute portions of the skin from some other part of the body by means either of special grafting-scissors or a sharp scalpel, and placing them on the granulating surface a short distance from the edge. Each of these grafts forms a new centre from which cicatrisation spreads; and it may not unfrequently be noticed, if one is placed near the margin when healing has become slack, that the cells on the other side, those which are growing from the already existing epidermis, suddenly wake up into activity too.



FIGS. 11 & 12.—Drawing illustrating the cicatrisation of sores by skin-grafting.

It is not necessary or advisable to include the whole thickness of the skin; it is quite sufficient if the cells which still retain their power of growth are used. No real wound should be left; at the most, the spot from which the skin is taken should be reddened or marked with one or two dots of blood coming from papillæ, the apices of which have been taken off; and the size of the part that is used need be no larger than that of an ordinary pin's head. If possible, grafts should always be taken from the patient's own body, and from some part where the epidermis is not too thick; but if no objection is raised, the skin from an amputated limb may be made use of, or that which is removed in the operation for phimosis, especially as the vitality of the epidermis is greater in the case of children.

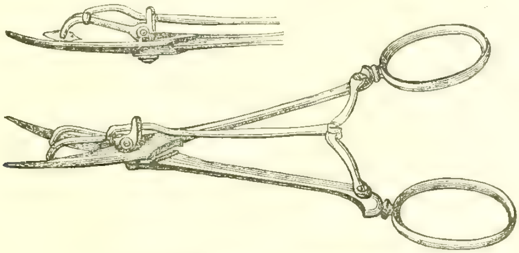


FIG. 13.—Scissors for skin-grafting.

Grafting is of no use unless the wound itself is healing at the edge; sometimes, when this is not the case—when the granulations are pale and œdematous—the grafts grow for a few days, but almost invariably they break down and disappear again; and they should always be placed with the natural surface downwards, about three-quarters of an inch from the margin, on that part of the wound, in other words, which is in other respects ready for cicatrisation. Great care should be taken not to make the surface bleed. The most satisfactory dressing is a single layer of gutta-percha tissue or oiled silk perforated with a number of minute openings, and covered with a considerable thickness of absorbent wood-wool. This may be left for a week or more, until the grafts are firmly set; the excess of discharge, which might otherwise wash them away or displace them, being absorbed through the perforations.

In the method advocated by Thiersch, actual portions of skin are used and the whole surface of the sore is covered over at once. It may be carried out in recent wounds, but it answers better in those which have been granulating for some little time, and in which the granulations are small and florid; a condition which usually follows the application of caustic or compression. The surface must first of all be thoroughly purified and washed with normal salt solution, compresses soaked in the same fluid being laid over the wound until the strips are ready. The most convenient situation from which to obtain the skin is the arm or thigh; the epidermis is first thoroughly scrubbed with a solution of corrosive sublimate or iodide of mercury in iodide of potash; then the antiseptic is washed away with salt solution, and long strips are cut off with a sharp razor as wide as the part will allow. The limb must be held firmly from beneath with one hand, so as to put the skin upon the stretch, and a shaving as long as is thought advisable quickly taken from the upper surface. The subcutaneous fat should not be included, but the whole thickness of the true skin is necessary (of course it is thinner at the sides) so as to take in the layer that contains the horizontal plexus of vessels. If the plasma can enter into these through the cut ends of the vertical ones through which they are supplied, the nutrition of the graft can practically be assured. Strip after strip obtained in this way is placed upon the raw surface and pressed firmly into position until the whole is covered. A layer of protective, perforated with numerous large openings, is placed upon them, and over this compresses wet with salt solution, which are changed every day.

As a rule the strips unite at once; occasionally the granulations break through, and sometimes the edges are lifted up by the collection of discharge beneath; even then the whole area rarely perishes.

Frog's skin (*Annals of Surgery*, Feb. 1889) has been used in the same way. The same preparation and precautions are necessary, the skin of the back being carefully detached from the neck downwards. The pigment-cells soon disappear; but apparently the skin itself lives, and forms a thin pellucid covering through which the deep colour of the vascular lymph beneath can be seen. After a time it becomes denser and more opaque, but it does not appear to possess the same power of resistance as human skin.

Wolfler has employed flaps of mucous membrane in the same way, obtaining them both from human beings after operation and from animals. Stricture of the urethra, for example, has been excised, and a graft of mucous membrane inserted in its place, with apparently good success; and defects have been remedied in the eyelids and elsewhere.

Complications of Repair

If the surface of the wound is irritated instead of being kept at rest, t becomes inflamed, and the inflammation continues so long as the irritant s at work. The process of destruction for the time the cause is acting is nore vigorous than that of repair; healing is delayed, the loss of tissue is greater than that due to the original hurt, and the wound increases in size, sometimes merely the surface melting away (suppuration and ulceration); sometimes, when the irritant is more intense, the base and edges perishing *en masse* (sloughing and gangrene). Open wounds are naturally more exposed to the action of the irritants than closed ones; they are always liable to infection from the air and from contact with foreign bodies, and until recently inflammation was regarded as a necessary factor in their repair. It cannot, however, be too strongly insisted upon, that it is a complication, and an absolutely unnecessary one, caused by the action of some fresh irritant. It does occur occasionally in subcutaneous injuries as well as in open ones, but it should not occur in either. The sole difference, why it is so rare in the one and so common in the other, is that the former are protected from all external injurious agents by the skin, the latter are not. As soon as the irritant, whatever it may be, is removed, the inflammation ceases, and if the tissues have sufficient vitality left, the process of repair at once begins to make headway again.

1. *Simple inflammation.*—This is the product of mechanical or chemical irritants, not generated by organisms living in the wound.

Friction, want of rest, the tension of a tight suture, the presence of an irritating dressing (even when it is antiseptic), the accumulation of extravasated blood or wound secretion, inert foreign bodies and many other irritants of a similar nature, may cause it. Repair advances more slowly or is stopped altogether, the area of redness spreads, the swelling becomes more marked, the temperature of the part rises, the pain becomes more severe, and the patient feels feverish. The gravity of the attack depends upon the nature of the irritant and the condition of nutrition. A tight suture will cause a rise of temperature of several degrees, and lead to a train of symptoms of altogether disproportionate severity. A bullet or a piece of silver wire, ivory pegs, or other similar inert substances, may remain embedded in the body for years, especially if they are fixed in some part that is not exposed to friction or movement. If they are near the skin or loose in the muscles, the irritation usually leads to the production of a capsule of cicatricial tissue, and not unfrequently, after remaining quiet for perhaps a number of years, suppuration suddenly sets in, the vitality of the tissues round becoming depressed by age or the addition of some slight injury.

If the cause is removed, the inflammation subsides, and repair gains the upper hand; if it continues, the vitality of the tissues is lowered, until at last they become too feeble to resist the assault of the pyogenic organisms, and suppuration follows.

2. *Septic inflammation.*—Decomposition of the blood or lymph that fills the wound is a much more powerful cause. The micro-organisms of putrefaction are destroyed by living tissues; on the other hand, they grow and thrive in the fluid that exudes from them, especially when it is kept at the temperature of the body, causing either *septic fever* or *sapræmia*, according

to the amount absorbed. If the wound is a recent one, and all the strata of loose cellular tissue round the bones and between the muscles are open and filled with extravasated blood, diffuse inflammation of the most terrible description is sure to follow, and very likely prove fatal from the intensity of the fever before there is time for suppuration. If, on the other hand, the tissues are better nourished, or the poison is not so active, and death does not ensue in the first two or three days from the sapræmia, suppuration sets in, the germs finding the soil that suits them best in the already half-killed tissues, and one of the varieties of suppurative inflammation follows, sometimes more than one.

3. *Suppuration.*—The pus of acute suppuration always contains certain organisms; it is believed, therefore, that it cannot occur without them, and that they are its cause. Ten or eleven different kinds are described as possessing this property, but only two, a staphylococcus and a streptococcus, are of common occurrence. They kill the leucocytes and transform them into pus-corpuscles; the tissues themselves, the walls of the vessels and the plasma that pours out through them are destroyed, and converted by their peptonising action into an albuminous fluid incapable of coagulation; and, so long as there is any tension or any other irritant to lower the vitality of the tissues round them, they spread their process of destruction far and wide. Over structures that are perfectly healthy they have no power. In children, therefore, and young and healthy adults, suppuration may be acute and severe, when there is tension or septic decomposition to help the germs, but it is limited; the nutrition of the tissues is too good for the micro-organisms to have any effect outside the immediate sphere of the other irritants; in those, on the other hand, whose constitutions are wrecked by disease or intemperance, resistance is enfeebled, and the suppuration is only too liable to spread.

That in the vast majority of instances these germs gain access through the wound is absolutely certain; suppuration is of common occurrence in open injuries, while it is the exception in subcutaneous ones. As, however, it does happen occasionally in the latter, and as some of the worst and most fatal forms of suppurative disease occur without a wound at all, it is clear there must be other modes of entrance too. Sometimes their presence may be accounted for by the existence of cutaneous lesions in other parts of the body; but, in all probability, as they abound in the alimentary and respiratory passages, they enter through the mucous membrane, and are distributed by the blood. It is only, however, when they meet with tissues that have been already injured in some other way, by cuts or bruises, tension, septic poisons, &c., that they are able to cause coagulation-necrosis, and suppuration.

A certain amount of pus, generally very thick and viscid in character, is occasionally found when the dressings are removed from a wound, forming a thin layer over some part which the skin has failed to cover. It causes no rise of temperature or fever, and the lymph beneath heals over rapidly as soon as the dressings are changed. Possibly, in many cases, it is not true pus (not the product of pyogenic microbes), but merely lymph which has perished owing to its distance from its base of nutrition and its contact with a foreign body. In other cases, however, micrococci are present, having reached the part through the dressings or in some other way, and then the only explanation is that, owing to the thorough vitality of the lymph around, and the absence of all other sources of irritation, they have been unable to effect more than the minimum of mischief. Suppuration of this description requires no special treatment; its existence is usually unknown until the dressings are changed.

Acute suppuration, on the other hand, accompanied by tension, is marked by very characteristic signs. There is often a chill at the beginning, or even a rigor; the temperature rises rapidly, the pulse becomes hard and frequent, the tongue is coated, the appetite lost, the skin hot and dry, the urine scanty and high-coloured; headache is always present, and particularly in children there is frequently more or less delirium. It is not material whether the suppuration is on the surface of a wound or deeply buried in the tissues; in either case the symptoms are the same, although in the latter they are much more severe, owing to the higher degree of tension. Undoubtedly, the chief reason is the absorption of the products of tissue-destruction, poisonous substances produced by the action of the pyogenic micro-organisms.

Round the wound everything is swollen and tense, the skin is hot, red, glazed, and exquisitely tender; often it pits on pressure, and there is œdema spreading up the inner side of the limb along the course of the great vessels, while the pain, especially at first, is violent and throbbing. Later, when the tissues round have recovered themselves, and thrown out a protecting barrier of lymph, these local signs become less marked, and at the same time the severity of the constitutional symptoms diminishes; but if, from any cause, the tension is allowed to return, the mischief at once becomes acute again.

The worst complications are those which follow the combination of septic decomposition, tension, and suppuration. If, in such a case as that mentioned already, in which the loose cellular tissue is filled in all directions with extravasated and decomposing blood, a fatal result does not ensue in the course of the first two or three days from sapræmia, and if the patient survives sufficiently long for suppuration to occur under high tension, there is not one of the forms of suppurative inflammation that may not follow; diffuse inflammation of the cellular tissue is certain, but lymphangitis, phlebitis, osteophlebitis, pyæmia, suppurative arteritis, secondary hæmorrhage, sloughing, and even gangrene may occur.

Treatment of Wounds

In every case the first consideration is to stop the bleeding by measures suited to the circumstances. What these are, and how they are to be used, will be dealt with later on in considering the injuries of vessels.

The essential points are to make sure that the wounded surfaces are absolutely clean; to bring them into perfect apposition with each other; and to protect them from sources of irritation, whether friction, movement, tension, or the assault of living organisms.

1. *Cleanliness*

Wounds are of two kinds. Some are inflicted by the surgeon in operating; others are accidental. In many respects there is a very material difference.

(1) A wound inflicted in the course of an operation should not require cleansing, except from the blood that covers and obscures the surface. Of course, where old sinuses are present, as in the removal of sequestra, or when the wound communicates with the intestine or the anus, the conditions are

entirely different. Everything that comes in contact with the wound or with the skin near it should be already clean. The operator's hands and arms should be well scrubbed with soap and water and a nail-brush. The skin round the wound should be treated in the same way, and then sponged with a five per cent. solution of carbolic acid. The instruments should be kept for at least half an hour in a solution of similar strength. Special care should be taken about the sponges, which should be kept in carbolic lotion; and nothing but a perfectly clean mackintosh or india-rubber sheet should be allowed near the wound. If these precautions are thoroughly carried out there is no need to wash the wound out, or to flush it with anything, unless it is desirable for the sake of checking oozing. Ovariotomy wounds, operations for hernia, excision of the breast, and amputation of limbs, for example, if the tissues are healthy and fairly well nourished, should heal at once by the first intention.

Contused and lacerated wounds, if they are perfectly clean, heal in the same manner; compound fractures by indirect violence, for example, very rarely suppurate; the dead fragments, which are always more abundant in such injuries, are quietly removed by the leucocytes; but there is more risk. In a simple incised wound the amount of injured tissue is exceedingly small, the structures on either side retain their vitality and power of resistance unimpaired; in contused wounds, on the other hand, the bruising is often considerable for some distance round, and there is always the fear, even if decomposition does not occur, that the pyogenic organisms may gain access to the part, as they sometimes do in subcutaneous injuries, and, finding structures already damaged, cause suppuration. The amount, however, is never serious unless there is some further cause—tension, want of rest, or decomposition—continuing to depress the vital power of the tissues around.

(2) Suspicious wounds and those which are known to be infected require an entirely different plan. It is certain that if the bacteria of putrefaction once gain entrance, and there is dead tissue or extravasated blood at the temperature of the body, they will produce a poison which causes very severe constitutional symptoms, lowers the vitality of the tissues, and renders them incapable of resisting the action of other germs. Steps must be taken, therefore, either to destroy the organisms, or to remove the material in which they grow, or preferably to do both.

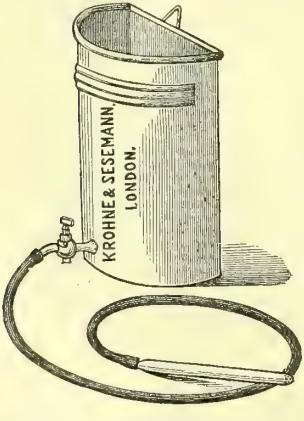


FIG. 14.—Irrigating can, for thoroughly washing out the recesses of a wound.

a. The first of these indications is fulfilled by thoroughly washing out the wound and scrubbing the skin round with an antiseptic lotion, using an irrigator or a piece of rubber tubing, and passing it down to the bottom of all the recesses. If it is in one of the extremities and otherwise conveniently placed, it is more satisfactory to immerse the injured part altogether in an antiseptic bath at the temperature of the body for two or three hours.

What antiseptic should be used is to a great extent a matter of personal choice; the ideal one has not been found yet. Corrosive sublimate, either alone, with chloride of ammonium (sal alembroth), or with a minute quantity hydrochloric acid, is very effectual. One part in a thousand is sufficient : general purification, one in five or ten for the irrigation; but it should ver be employed for large absorbing surfaces such as the pleura or perieum, or for complicated and extensive wounds in which there is any fear its retention. As a germicide there is no doubt of its value, but it has any drawbacks. Dysenteric diarrhœa, vomiting, collapse, and even death ve been known to follow its use; in one case under my care (compound slocation of the ankle-joint) salivation was caused before the odour of demposition disappeared; and it ruins any steel instruments with which it mes into contact. Further, it forms an insoluble compound with albumin, iich is said to be almost inert, but this difficulty is to a great extent overme by the addition of chloride of ammonium or hydrochloric acid. Lister s lately been experimenting with a double cyanide of mercury and zinc (of iknown composition) which may prove more effectual.

Carbolic acid possesses the advantage of being volatile, but it too is by means perfect. According to Koch, instruments to be absolutely pure ould be left for at least two days soaking in a five per cent. solution. One rt in forty is the ordinary strength for cleansing wounds; one in twenty r instruments, sponges, &c. Olive-green urine, which darkens on exposure light, is not uncommon after its use; headache, giddiness, and sickness casionally occur; and instances of extreme depression with low temperare and fatal collapse have been recorded. Further, it distinctly tends to icourage oozing from the surface of a wound by its action upon fresh bloodots, and the amount of discharge afterwards is always excessive.

Other substances are recommended from time to time, but with very few ceptions they do not appear to obtain general recognition. Boracic acid practically non-poisonous, and may be used either as a saturated solution water, or even dusted upon the wounded surface, but it is not nearly so fectual. Thiersch's solution is formed of two parts of salicylic acid, twelve boracic acid, and one thousand of water. Hydronaphthol is strongly reommended as non-poisonous and as powerful as corrosive sublimate under ie conditions of actual practice. It is very soluble in alcohol, but only ightly so in cold water. Salufer succeeds very well in the hands of some, id appears perfectly safe. Eucalyptus preparations are very agreeable at rst, but patients are apt to get tired of the smell. Chloride of zinc, which stated to be almost inert so far as germs are concerned, is undoubtedly of ery great value under special conditions.

Whatever antiseptic is used, unless it is intended to treat the injury by continuous bath, or there is some condition rendering it impracticable, it most important to keep the surface dry and check the amount of discharge s much as possible. Germs cannot grow without fluid. For this reason amgee preferred equal parts of spirit and water, a saturated solution of orax with about one-eighth of glycerine, and equal parts of water, lycerine, and methylated spirit, to the watery solution of any antiseptic.

This is probably one of the chief reasons why iodoform has met with uch favour. Its smell is exceedingly peculiar, very penetrating, and bjectionable from its associations; there have been many instances of erious poisoning, and even of death from its absorption; it is by no means ertain that it is a germicide; yet as a matter of clinical experience there an be no question that it forms a most valuable dressing for wounds. The æmorrhage is stopped; the surface becomes dry; the amount of discharge is reduced to a minimum, and repair takes place rapidly, beneath the crust that forms, without suppuration or decomposition. It is chiefly used in the form of powder, but it may be dissolved in ether for special purposes, or formed into an emulsion with glycerine, or sprinkled over moist gauze, and then well rubbed into the meshes; and it may be applied to quite recent wounds or to those that are already suppurating. Elderly people are said to be more liable to its effects than others, but, as in some cases very large amounts have been used without any ill result, it is probable the susceptibility depends chiefly upon individual peculiarities. An erythematous rash, sometimes starting from the neighbourhood of the wound, sometimes general, is tolerably frequent. Anorexia, headache, and great depression occur in the milder cases; delirium, sleeplessness, and even convulsions in those that are more severe; while in the worst of all the pulse is rapid and thready, the surface of the body cold, and the prostration extreme from the very first. It appears to be excreted by the kidneys as an iodide, and it has been suggested that poisoning only occurs when the action of these organs fails, possibly from the formation of some compound with an albumin.

b. The second indication is to keep the wound clean. Germs cannot live without fluid, and have little or no power on tissues that are perfectly healthy. If the interior of the wound is kept dry, and the vitality of the structures around it is unimpaired, they are practically innocuous.

Unfortunately cleansing a wound with an antiseptic causes other effects as well. All antiseptics injure the tissues they touch to a greater or less extent, and increase the amount of fluid poured out (carbolic acid is probably the worst in this respect, iodoform the best); and many of them are used with water, which, unless it is thoroughly sponged out (again an irritant, of some importance too, especially in connection with the peritoneum), adds still more to the quantity. In a simple incised wound, if the surfaces are brought together and pressure is properly applied, the amount of exudation is so small that it may be left to the natural process of absorption. Contused and lacerated wounds, in which the oozing has been completely checked, may, if not too much handled, be treated in the same way; or at most a little opening may be left at one angle, so that any great excess of fluid can drain off and be absorbed by the dressing covering it. But a wound that has been thoroughly cleansed, and the surface of which has been sponged or washed with strong antiseptics, requires something more. If it is left open, the fluid that is poured out naturally can escape at once; but if the skin is united over it, and no precaution is taken, the interior no longer remains clean; exudation is more rapid than absorption; fluid collects; tension is set up; inflammation follows, and if nothing is done suppuration is certain; the germs gain access to the part, and destroy the leucocytes in just the same way as they sometimes do when a simple bruise is constantly rubbed or hurt.

To keep such a wound clean therefore, and to prevent tension and its consequences, either the edges of the skin must not be united, or, if they are, a system of drainage must be employed. The method in which this is carried out depends upon the way in which the surfaces of the wound are adjusted and held together.

2. *Apposition of the wound surfaces*

Want of cleanliness is altogether fatal to repair: the tissues cannot close the wound until by the production of vascular granulation-tissue they have ejected all injurious agents, at a certain sacrifice. Given cleanliness, the rapidity with which repair is effected depends upon accuracy of apposition. Irregular injuries with uneven cavities are gradually filled from the bottom and the sides, but the process, in comparison with those in which the surfaces are properly adjusted, is very slow, and the amount of cicatricial tissue much greater.

Accuracy of apposition is effected by attention to position; pressure; sutures; and strapping.

Position.—In operations, incisions are planned to avoid tension and to allow wounded surfaces to fall together of themselves. Natural folds are followed as far as possible, and gravity is carefully considered with regard to the attitude of the patient. In chance wounds, the position of the body and limbs must be arranged to suit the circumstances. A great deal can sometimes be effected by this, but it must be recollected that discomfort may cause fever. In many plastic operations the position of the patient has to be fixed, and this cannot be avoided.

Pressure.—Properly applied, this is of the greatest assistance. It keeps the deeper parts of the wounds together as well as the superficial ones; prevents the formation of a cavity in which fluid can collect; checks the tendency to effusion, and assists the absorption of that which has already been poured out. Every structure in the body exists under a certain degree of tension; as soon as the skin is divided, this disappears; and one object of the dressings applied to a wounded surface is to restore it to its natural condition until repair is completed.

The ideal dressing is perfectly soft, elastic, absorbent in the highest degree, and impregnated with something that will make it safe against putrefaction without rendering it in the least irritating. If these conditions are fulfilled, and if abundance of the material is used, an amputation wound, or such a one as is produced in arthrectomy, may often be left a fortnight, or even longer, untouched, and only two or three dressings at the most are required. Absorbent cotton-wool, wood-wool wadding, treated with corrosive sublimate, prepared moss, and sponges wrung out of carbolic (the last especially if elastic pressure is required to stop hæmorrhage) are the most useful. A strip should be laid on either side of the wound, some little distance from the edge, so as to press the deeper parts well together, and as it were force the actual line somewhat outwards; and then all the space round and in between should be thoroughly and carefully packed, especial attention being paid to the hollows between the bones. Over this a soft elastic bandage is placed, without reverses; or if a greater degree of firmness is required, torn strips of millboard, soaked perhaps in plaster cream, as recommended by Gamgee, and then the bandage over these. The ease and comfort of this arrangement can hardly be surpassed. Immobility is perfect; the patient feels that all is secure; tension is prevented; there is no cavity in which fluid can collect; the small amount that is not taken up by the tissues is driven through the edges of the wound and harmlessly absorbed at once; vascular dilatation cannot take place to excess, and the apposition of the injured surfaces is as exact as it is possible to make them.

Strapping.—This is either employed in superficial wounds by itself, or in deeper ones as an adjunct to sutures, for the purpose of distributing tension and of immobilising structures on either side. In operations on the breast, for example, one or more broad strips may be advantageously brought up from the region of the back to support the lower flap, draw it upwards, taking the tension off the sutures, and keep it firmly pressed against the ribs.

Sutures are of various kinds and various materials. Catgut of different degrees of thickness and hardened more or less in chromic acid, according to the strength and endurance required, is the most useful. Silver or iron wire possesses the advantage of being absolutely unirritating and of being easily fastened, but requires removal; and the same may be said of silk. If properly prepared, and so arranged that no tension falls upon them, any of these materials may be left for weeks without causing the least irritation; but wire and silk almost always require to be removed at last: catgut removes itself.

Silkworm gut, softened beforehand in carbolic lotion, so that it will tie more easily, is especially useful for plastic operations. Horsehair is occasionally employed where there is no tension; and in comparatively rare cases other materials are used as well.

The method is still more variable; the object is to secure accurate adaptation of the whole depth of the wound without causing tension upon it anywhere. In deep-seated or complex injuries this is only possible by means of *buried sutures*, which must necessarily be of catgut. Layer after layer of tissue is accurately adjusted and secured *in situ*, periosteum to periosteum, muscle to muscle, and fascia to fascia. The deepest sutures are fastened the most firmly: the superficial ones are not so tight, so that if anywhere the amount of effusion (owing to some accidental source of irritation) is in excess of absorption, the fluid may make its way in the direction of least resistance, towards the surface. It is only by means of this kind that large and complex wounds, those for example left by amputations, can be safely secured without drainage; but of course the surfaces must be perfectly clean and healthy, fit and ready to cohere together at once. In the presence of suppuration or of decomposition, sutures used in this way could only lead to the most disastrous consequences.

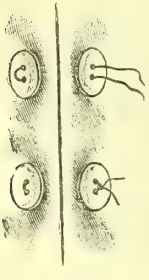


FIG. 15.—Button suture.

Deep sutures (*sutures of support*) aim at effecting the same result, but at the expense of tension and pressure upon the skin some little distance off. *Button sutures*, for example (fig. 15), are cut from pieces of stout sheet lead of various shapes and sizes. One of these is placed on either side of the wound, some little distance away; and while the two are brought together as closely as is thought desirable by the hands of an assistant, a stout silver wire is passed deeply across from one to the other, and fastened in a slit cut in the side of the lead. This relieves the edges of any tension by transferring it to a greater distance and spreading it over a wider surface; but, though they are useful in such operations as excision of the breast, they do not secure nearly the same accuracy of apposition for the deeper parts. The same may be said of the *quill suture* (fig. 16), in which longitudinal rigid supports are laid a little distance from the edges of an incised wound and fastened to each other by deep ties of wire or some other unirritating material. Strong curved needles set in a handle are required for them; the skin and the deeper structures are transfixed, first, on one side, and then, in the opposite direction, on the other; if the needle is threaded before it is passed the loop is caught and drawn out, so that a double suture is left; if not, it is threaded when the point projects through the skin on the farther side and withdrawn, carrying the suture with it. As a rule such sutures cannot be left more than four or five days, but everything depends upon the degree of tension. Their chief object is to prevent any strain upon the superficial ones, and as soon as these appear secure they should be cut, even if they do not require it of themselves.

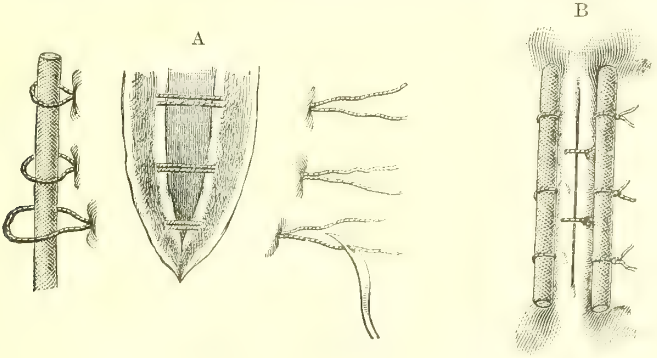


FIG. 16.—The quilled suture.

The *twisted* or *figure-of-eight suture* is chiefly used after removal of part of the lip in order to bring the whole thickness of the cut surfaces into apposition. It is very rarely required for simple harelip, sutures of silkworm gut being nearly always sufficient. Steel pins, silvered over, are introduced about half an inch from the margin of the wound; passed obliquely down through the whole thickness on one side as far as, but not through, the mucous membrane; then carried across the cleft (fig. 17), made to enter at a corresponding point on the other side, and passed through to the cutaneous surface, piercing the tissues in the opposite order. The surfaces are then brought together by lateral pressure and a piece of stout silk twisted round the projecting ends in a figure-of-eight. The point and the head of the pin (if it projects too far) are cut off with pliers; the skin beneath is guarded with a small piece of lint or strapping; and the whole is left exposed to the air so that the blood may dry upon the surface and form an additional protection. The pins should be removed in forty-eight hours, or suppuration is almost sure to occur round them, and the marks caused in this way may be more conspicuous than the linear cicatrix of the operation. If possible they should be withdrawn by twisting them round, so as to leave the silk with the coagulated blood still adherent to the surfaces of the skin. If it comes away, strapping must be used as a support.

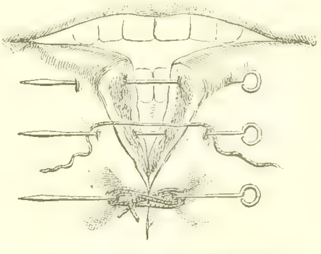


FIG. 17.—The twisted suture.

Superficial sutures are interrupted or continuous, and may be of any material—catgut, wire, silk, or horsehair. Ordinary straight needles with triangular points, or Hagedorn's curved ones (which are flattened from side to side, not like the ordinary ones from above downwards), are the best, the edges of the wound being raised well up with the finger and thumb, so that the needle may be passed at one thrust through both.

In the *interrupted suture*, the material is cut, and knotted or twisted as the case requires, each time the incision is crossed, care being taken that the knot always lies to one side and that there is no dragging or puckering of the skin. The object of a superficial suture is not to draw the two edges together (this should be done by pressure, position, or other means), but to hold them, gently but firmly, facing each other. In all cases the knot should be a true one (fig. 18).

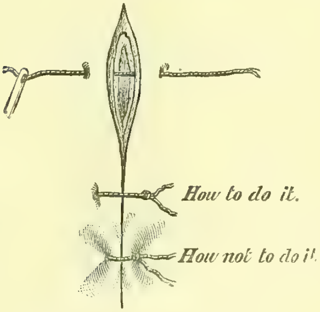


Fig. 18.—The interrupted suture.

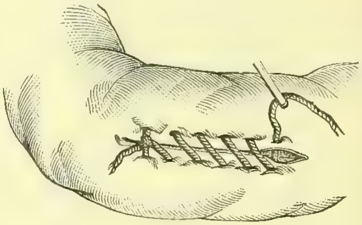


Fig. 19.—The glovers' suture.

In the *continuous suture* there is only one knot at each end, or if the line is very long, one here and there. The varieties are almost endless. The common one is the ordinary *glovers' stitch* (fig. 19), simply over and over. Or this is modified by using a double thread, except for the first perforation and the last; these have only a single one, so that two ends project from the skin, one on either side of the wound at its two extremities, and the suture can be made secure at once by tying them together across the line.

In *the quilt suture* (fig. 20), the needle is carried through the two flaps, and then back again, so that a loop is left on one side, and the two ends on the other. These two ends can either be secured together at once; or one may be carried in the same manner along the whole length of the wound. Sometimes this is combined with the glovers' suture: an outside row of quilt stitching is carried along the whole distance to draw the flaps together, and then a line of glovers' is brought back along the edges to secure accurate apposition. The two ends of the thread are thus brought close together, and may be tied at once. This is exceedingly useful in cases in which tension is feared, but as a rule the outside row requires division on the third day.

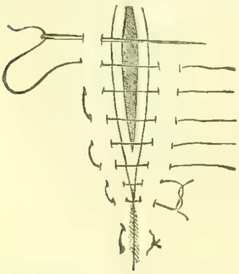


Fig. 20.—The quilt suture as applied to the intestine.

The great advantage of the continuous suture is the rapidity with which it is applied and the accuracy it ensures. There is, on the other hand, the serious objection that if from the presence of tension at one single spot it must be cut before the wound has healed, the whole is likely to give way. Of course it should never be employed by itself as a circular suture round the intestine or any other hollow tube, as it would become loose at once if this collapsed.

Other forms of suture, Lembert's, Jobert's, &c., are described in connection with special operations.

Drainage.—The question of drainage depends upon the character of the wound. After any injury, no matter how simple, the amount of exudation is in excess of absorption. If the difference is only slight, the tissues, aided by judicious pressure and rest, are able to deal with it after a little time, and the balance is restored. If, however, the difference is considerable, and no exit for the surplus provided, there is a certain degree of tension; this inflicts a fresh injury, and inflammation follows.

(*a*) *Simple incised wounds.*—If the bleeding is stayed (at least that from vessels of any size, for too much care may be shown in this matter and more harm done than good), the surface clean, and apposition accurate, there is the minimum of exudation; absorption begins at once; and provided no fresh injury is inflicted, the balance is restored again almost immediately. The least friction or movement and it is all undone.

(*b*) *Contused and lacerated wounds.*—Accurate apposition is often impossible; a cavity is left which must be obliterated by the growth of vascular granulation-tissue from the sides and bottom. Whether drainage is required or not depends upon the character of the wound and the amount of irritation to which it is subjected.

Supposing it is perfectly clean and there is sufficient skin to cover it in, the wound as soon as it is left fills with blood and lymph from the dilated vessels around, until the pressure in the interior is equal to that exerted by the dressings over it; in other words, it is almost in the same condition as a severe contusion. The sole difference is in the amount of fluid; in the one case the pressure of the unbroken skin limits the exudation from the first, and there is no source of irritation other than the tension; in the other, owing to exposure to the air, manipulation, the application of dressings and other causes, even when everything is absolutely clean, the quantity is very much more abundant, and the absorbing power less. Accordingly, it is usually advisable to provide some means for escape, at least for the first twenty-four hours; either the edges of the wound are left slightly separated at one spot and an absorbent dressing applied; or if it is thought that is not likely to be sufficient, a small drainage-tube, a few threads of horsehair, or a few strands of catgut, are placed in the cavity with one end projecting on the skin. At the end of twenty-four hours all excess should cease, and if a fair amount of pressure is kept up over the wounded surface, absorption should balance secretion.

If the skin is insufficient, so that an open wound is left, the same plan may still be tried, only now an artificial protecting covering must be formed. In small wounds which can be kept at perfect rest this may be done with iodoform; the powder is dusted over the glazing surface, a dry scab forms, the wound is absolutely protected and the pressure is sufficient to check the exudation. In larger ones an attempt may be made in the same direction by what is known as Schede's dressing. Immediately over the wound is placed some fine rubber or gutta-percha tissue, perfectly clean, but not moistened with carbolic; it should be just large enough to overlap the edges of the wound. This is covered with a thick layer of some absorbent dressing (impregnated with an antiseptic to act as an additional safeguard against putrefaction), and the whole is then firmly and evenly bandaged over. The outer dressings absorb the surplus serum that exudes from the lymph that fills the wound, and the thin film of rubber tissue acts as the scab to protect the surface.

(*c*) *Irritated and foul wounds.*—Where there is perfect cleanliness, and the parts are kept absolutely at rest, these methods answer admirably and nothing more is wanted. If apposition is not quite accurate, if there has been much bruising or handling, or if (what comes to the same thing) the wound has been foul and has been subjected to a thorough cleansing, the amount of lymph that is poured out is at first too great for absorption, and an escape must be provided. The cause, however, is only a temporary one ; and generally, if the dressing is absorbent, a dependent opening is all that is required. Sometimes a small drain is advisable, but after the first twenty-four hours, all excess should cease (there being nothing further to cause it), and uniform compression with an absorbent dressing should be sufficient.

This is not the case when the irritation is continuous, whether it is due to the wound remaining foul, or to its being subjected to constant friction or other source of irritation. The cause is then a continuous one, fresh injury is constantly being inflicted upon the tissues, and the amount of exudation continues to increase in a measure that is only regulated by the extent and intensity of the irritant. This fluid, in its turn, if the wound is closed, affects the already injured tissues by the tension that it causes, or in the case of septic decomposition, by the poisons it contains as well ; the wound becomes hot and swollen, the pain much more severe, the temperature rises, and unless the most ample provision is made for free and continuous escape, some form of suppurative disease is certain. Drainage acts in two ways. It diminishes the tension, relieving the pain and checking the absorption of poisonous fluids from the interior, and it stops septic decomposition by drawing off the fluid on which the germs grow and gradually starving them out.

Chassaignac's tubes have never been improved upon, except in the quality of the rubber. They are of any length and of any diameter, the sides perforated with openings here and there, and sufficiently strong not to collapse. In using them, one end should be passed down to the bottom of the cavity, the other brought out through the wound at the most convenient spot and cut flush with the skin. It is better that they should point downwards for the sake of gravity, but, provided the outside pressure is properly arranged, there is no absolute necessity for it. The end should be secured with a silk ligature, so that it may not slip inside altogether. One or more may be used, according, not so much to the extent of the wound as its complexity, and care should be taken that they are sufficiently large ; small ones are filled with blood-clot almost at once, and are often injurious from the false sense of security they give. When not in use they should be kept in a five per cent. solution of carbolic acid.

As a rule, if the wound surface was clean, a drainage-tube may be removed at the end of twenty-four hours. If there was much oozing it will be filled with clot, if there was not it is not required any further. Whether it should be introduced again for a part of the distance, through the skin for example, depends upon the amount of discharge, the degree of tension, and the presence of layers of fascia which might render the opening valvular. If the injury was from the first suspicious, or if there is any fear of septic lecomposition or of suppuration, and the edges of the skin have been rought together, it should be replaced and only shortened by degrees as he cavity fills up.

As it is not unfrequently necessary to dress a wound on the day after an peration, solely for the purpose of removing a drainage-tube, many attempts ave been made to dispense with their use, or to employ only such as are spontaneously absorbed. Buried sutures cannot be recommended except vhen the wound is a clean incised one, and then they are rarely wanted. Neuber's decalcified bone tubes cannot be relied upon, and the chicken bone lrains of MacEwen are only to be trusted in special cases; the rate of oftening is not uniform, and irregular pressure may cause kinking. Catgut lrains are rarely employed, they do not really exert any capillary attraction, nd they tend to block the opening by softening and swelling up. Horsehair s a little better, but if a drainage-tube must be used in these cases (and it s very questionable whether, when the amount of discharge is so small, it vould not be better to trust at once to the absorptive power of the tissues nder uniform compression), a thin slip of gutta-percha tissue is better than ny. It is not so likely to become displaced, it prevents the edges of the kin uniting, and by its irregularity forms a kind of trough along which he fluid can escape.

Of itself, the mere presence of a drainage-tube is so mild an irritant that vhenever there is the least suspicion as to the cleanliness of a wound the recaution should be adopted.

3. *Protection*

Open wounds require protection from without even more than from within. The surface may have been absolutely clean at the time of the operation, and nay have been protected from all possibility of tension or of other sources of nternal irritation afterwards; but this is not sufficient, other irritants may gain access to it from the outside, and if speedy union is desired the wound nust be made equally secure against these. The chief are friction, movement, and the presence of certain micro-organisms, especially those of putrefaction. These, in particular, if they can find a suitable soil in the neighbourhood of a wound, are practically certain to work their way into the nterior, and, once there, make the secretion decompose.

The essentials of a perfect dressing are not difficult to enumerate, though hey are not so easily found in combination. It must be perfectly soft, bsolutely unirritating to the most delicate structure, sufficiently elastic to eep up an equal degree of pressure all over, utterly unable itself to undergo lecomposition, and capable of absorbing an indefinite amount of albuminous luid without clogging. Wood-wool wadding prepared with corrosive sublimate, salicylic wool, absorbent cotton-wool, and other similar substances nswer these requirements fairly well; and they possess the advantage of eing cheap at the same time, for although a dressing of any one of these naterials may and often does last for a fortnight without being changed, a onsiderable quantity is required each time, especially in the case of large vounds.

In some instances in which a raw surface or a fresh blood-clot is left uncovered by skin, a thin piece of rubber tissue, a shade larger than the wound, hould be laid over it, to prevent the dressing becoming too firmly adherent, r by its absorptive power desiccating the tissues too deeply; in all other cases it should be placed immediately upon the skin. No water-proof or air-proof covering should be laid over it; the albuminous secretion of the wound is absorbed and becomes dried at once, forming a protective covering which, if undisturbed, is absolutely impenetrable to any germ. The amount of pressure to be used in each case can only be judged of by experience; if, however, the dressings are of sufficient thickness, it can scarcely be too great. The firmer it is (always provided it is perfectly uniform and falls upon the right parts) the greater the degree of immobility and the less the risk of tension or of the accumulation of discharge.

Subsequent Treatment

The subsequent treatment of a wound is regulated altogether by the complications that follow. If all the conditions essential to speedy repair are perfect, the dressing need not be changed until it is sound. An ovariotomy wound, for example, is often healed before the dressings are removed. Catgut sutures are absorbed so that the knots come away of themselves; silk or wire ones must be cut, but so long as there is no tension upon them they lie perfectly inert in a wound that heals at once.

If, owing to the amount of oozing, it is thought advisable to use a drainage-tube, the dressing must be changed, as a rule, before the third day, for the sake of removing it. I have often left them a week without harm, although occasionally the newly formed lymph that surrounds them is bruised and made to bleed as they are withdrawn; but unless the wounds are badly contused or have been subjected to a great deal of manipulation, they are of little benefit after twenty-four hours, although they may not cause any actual mischief. In wounds that are foul, of course, the conditions are different.

A certain degree of traumatic fever is to be expected in the case of any large wound. The temperature may drop two or even more degrees the evening after an operation, or it may begin to rise at once; the next morning in the milder cases it is normal, in those that are more severe it may be 101° F., but its highest point should be reached within thirty hours. If it does not begin to subside then (it may, even in subcutaneous injuries, take nearly a week before it drops to the normal) it means either that there is some degree of tension, whether arising from a tight suture or from an unexpected amount of oozing, and that it had better be relieved, or else that the precautions have failed, that decomposition has begun, and that septic fever is commencing.

Special Kinds of Wounds

Punctured wounds inflicted with a perfectly clean sharp instrument require the same treatment as incised ones; the only fear is the difficulty of excluding injury to deep-seated structures; the bladder, for example, may be penetrated through the sacrosciatic foramen. Even if the instrument was blunt, so that the edges are contused, the same plan may be adopted; the wounds caused by small revolver bullets nearly always heal readily if they are not interfered with and no fragments of clothing are carried in. But if the weapon was foul, it is better to enlarge the opening at once, sponge it out with an antiseptic, and drain it thoroughly. If this is not done the surface is very likely to heal, while deep-seated suppuration under high tension occurs beneath.

Subcutaneous section is often employed by surgeons when it is wished to divide important structures such as tendons, fasciæ, or bones, for the purpose of correcting deformity. A minute puncture only is made through the skin at some specially chosen spot, frequently at a little distance from the part to be divided, if that enables it to lie in one of the natural folds or avoid mportant structures with greater certainty. Then the instrument, a saw, chisel, or fine tenotomy-knife, as the case requires, is pushed in and the division effected with as little disturbance of the structures around as possible. The wound is closed with some absorbent dressing, and the part carefully packed and bandaged, or placed upon a splint. If the instrument used is perfectly clean and no tension, friction, or undue movement is allowed, the wound heals immediately without any more risk of suppuration than in a contusion treated with similar precautions.

Open wounds are exactly the opposite; there is not sufficient skin to cover them in, and they have to heal by granulations from the side and base. If they are well protected from all sources of irritation none of the leucocytes are wasted as pus, the whole of the lymph becomes organised—the deeper part into some form of connective tissue, the more superficial into epithelium.

Contused and lacerated wounds have been described already. They are especially serious, both from the widely-spread injury sustained by the tissues, and the difficulty of ensuring thorough cleansing. If the structures round are badly hurt, a certain degree of suppuration is not uncommon, even when the wound is perfectly clean; the injured tissues are unable to withstand the assault of the pyogenic microbes; but the result under these conditions is never serious, unless there is tension or decomposition or some other persistent irritant. If these occur there is no limit to the consequences that may follow.

Infected wounds must be thoroughly cleansed with corrosive sublimate or chloride of zinc, and then, according to their character, either dried completely and covered with iodoform, any accumulation being prevented by the use of drainage-tubes and absorbent dressings, or left widely open so that there may be no retention of discharge. If the tissues are the stronger, a barrier of vascular lymph gradually forms, and as it organises, closes the wound; if, on the other hand, they are enfeebled from intemperance, Bright's disease, or any other cause, or if the action of the poison is assisted by tension, want of rest, or any other irritant, the process of destruction continues to spread.

CICATRICES

A cicatrix or scar is the splice of fibrous tissue formed by the organisation of the lymph that fills a wound. At first it is soft and vascular; then, as the fibres of which it is composed contract, it becomes dense and hard; the newly formed vessels disappear, and only a dead white inelastic layer is left. There are no lymphatic or elastic fibres in it; the surface is smooth, formed of a few layers of epithelial cells; no papillæ, hair-bulbs, or glands are ever developed if once they have been destroyed; and except in certain cases there is no reproduction of special tissues. As time advances and the cicatrix continues to contract, it may gradually (at least, in the case of union of the first intention) merge into the surrounding tissues and almost disappear; or, on the other hand, it may become more and more conspicuous and lead to the most fearful deformity.

This depends chiefly upon its amount. In wounds that heal by the first intention there is exceedingly little (in what used to be called immediate union it was said there was none at all); in those in which the amount is greater, as when some of the skin has been destroyed, a certain degree of contraction usually follows; and where the cavity was a deep one with a fixed base (formed of bone or fascia) an unsightly depression may be left; but it is only when suppuration occurs, and the destruction involves a considerable extent of surface, that the full effect is produced. Burns that destroy the whole thickness of the true skin often leave the most fearful deformity. The arm may be tied down to the side, the lower lip (fig. 21) dragged down to the sternum, the eyelids pulled down or else completely closed, the mouth contracted to an orifice so narrow that the patient is scarcely able to feed himself, and the œsophagus converted into a fibrous cord for the greater part of its length. The contraction begins in the deeper layers of the granulation-tissue long before the wound has closed, and where the true skin has been destroyed through its whole thickness it progresses steadily and relentlessly, taking advantage of every momentary neglect, and never giving up the ground it has once gained until in many cases further shortening is physically impossible.

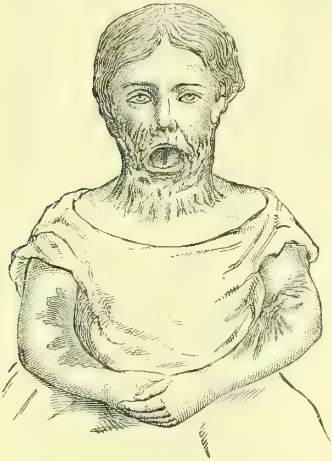


Fig. 21.—Effects of burn on neck, contraction of cicatrix.

This tendency can be checked to some extent while the wound is healing. Prolonged suppuration undoubtedly favours it, and much may be done to prevent this by epidermic grafting, although the result is often very disheartening. Splints and other appliances can be used to retain the limbs in suitable positions, but as a rule it is necessary to continue their employment a long time after everything is sound, and, as a matter of fact, what-

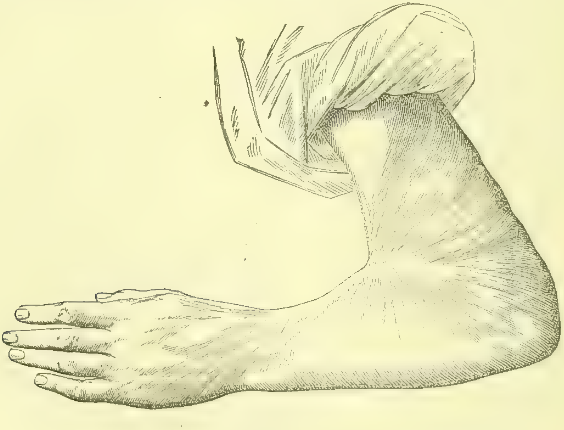


Fig. 22.—Contraction of cicatrix after a burn.

er is done, the steady persistence of the cicatricial tissue is almost sure to in the day at last, especially if the injury involves the flexor surface of a nt (fig. 22).

The best hope then lies in plastic surgery, the transplantation of a flap om some other part of the body into a space made by the division of the catrix. Mere section seldom is of much use. There are two ways in which is may be effected, but in both the whole depth and extent of the cicatrix, least from one side to the other, must be thoroughly excised, an operation quiring great care, as not un- equently all the important nerves d vessels of a limb are entangled it. In one of the fashions per- ctly fresh flaps of skin are used, t attached at one end, or preferably both. The outline must first be refully marked out, and then the in and subcutaneous tissue divided wn to the aponeurosis, leaving a se sufficiently broad for nutrition, d if possible including the chief ssels. As a rule, the length ould not exceed three times the dth, the measurements being ken before the operation is begun. ien the flap is carefully dissected , laid in position, and secured curately by sutures all round the ee margin. If it is only left tached at one end, it must be isted into the required situation, re being taken not to strangulate ; if at both, so that it forms a nd of bridge, the raw surface must placed beneath it; a strip, for ample, may be dissected up from e thigh, leaving it attached at th ends and the forearm slipped under. Then the whole must be made solutely secure by means of plaster bandages, each part being bandaged st, and then the two fixed together. The time when the pedicle may divided depends upon the degree of union. If the surface of the flap s formed definite cohesions to its bed, it may be done as early as the ghth day; in most cases, however, especially if the margins only have ited, it answers better to wait fourteen; and when the pedicle has been uch twisted, and the vitality appears low, longer still. MacCormac has ed a constricting india-rubber band round the pedicle for some days evious to division, so as to establish to some extent a collateral circulation st.

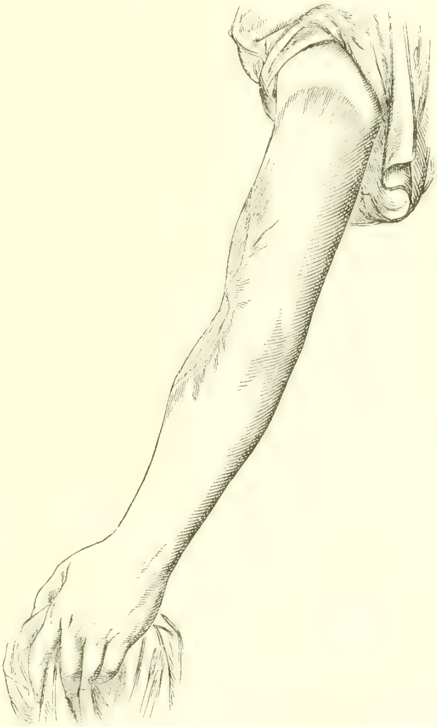


Fig. 23.—The same after incisions and extension.

In the other fashion the same precautions are adopted, but the flap is ssected up first, separated from its natural bed by a strip of gutta-percha ssue, and left to granulate all over its under surface; then, at the end of vo or three weeks, as the case may be, when it is thick and vascular, it is transplanted into its freshly prepared site. In the meanwhile it shrinks to comparatively a very small size, but it expands again to some extent afterwards. Union between the freshened surface and the layer of granulations apparently takes place without any difficulty; and as there is less fear of sloughing, the pedicle can usually be detached rather earlier than when a fresh flap is used.

Minor degrees of contraction may be treated by means of extension, (provided sound skin can be found above and below, on which to fix the apparatus); by simple division, and extension afterwards, or by multiple incisions, as for example in the case of the fingers, when numerous ∧ shaped cuts may be made along a contracting scar, and the edges brought together from side to side. Occasionally a long and narrow cicatrix can be dissected out with the view of securing primary union in its place.

Cicatrices are liable to various troubles, some of which at least are due to their feeble vitality.

Ulceration is the most common. On the legs especially, the scars that are left by chronic varicose ulcers rarely last any length of time; the same causes continue at work, and even when the original wound heals over, it is quickly reopened by the breaking down of the lowly organised cicatrix. The scars of extensive burns may remain unhealed for years.

Neuralgia occurs sometimes. It may be due to a nerve-filament caught in the scar-tissue, and then there is one very painful spot which gives an almost electric shock every time it is touched; or in other cases to a kind of malnutrition, the cause of which is not known. There is a constant burning pain, but the scar itself is as cold as ice, the skin all round is glazed, and does not fall into its natural folds; the colour is a dusky livid red, returning very slowly after compression, and the whole part feels hard and dense. Usually this is met with after amputations, and it may return again and again, even when the whole stump is taken away and fresh flaps formed from the natural skin above.

Itching is sometimes complained of, and may be described as simply intolerable, without any cause being found. Probably it is due to irritation of some of the nerve-filaments in the cicatrix, or it may depend upon the condition of the circulation. Heat usually relieves it, but in some cases cold and compression answer better.

Hypertrophy is very common, and passes by imperceptible steps into what is known as *cheloid*. Addison's or true cheloid must be clearly distinguished, as it is of an entirely different character. This variety forms a firm, hard mass, with a more or less rounded surface, from which spurs and branches run out in all directions. The general outline is most irregular; as a rule, it is smooth and glossy on the surface, with a few dilated capillaries here and there; but often the spurs are perfectly white. It is rarely tender when touched, although it may be the seat of the most persistent itching. It consists of nothing but a closely packed mass of fibrous tissue, with bundles running for the most part parallel to the surface, and of course it has no definite outline.

Cheloid may occur in any cicatrix, and at any time after its formation. I have known it develop after a blister; but it is more common after burns than anything else, especially if there has been prolonged suppuration. Smallpox scars are not unfrequently attacked by it, and in some instances, in which the marks are close together, the whole face is transformed into a ense, rigid mask, perfectly expressionless, and covered with seams and vid nodules. It is not uncommon to find it attacking several scars at the ame time; and I have known it occur in four members of the same family. here is no cure for it. Excision is rarely practicable, and even when it is ossible, it is almost certain to be followed by recurrence.

Epithelioma not uncommonly developes from cicatrices; and sometimes, specially in the leg, it extends deeply into the subjacent structures before is noticed by the patient. Enlargement of the lymphatic glands does not ccur so soon as in some of the other varieties, but the treatment is the ame.

CHAPTER III

BURNS AND SCALDS

Burns and scalds are due to the local action of intense heat; there is no real distinction between the two, the effect in each case depending upon the temperature and the length of time contact is maintained, whether it is hot-air, steam, flame, boiling water, oleaginous or other liquids with a high boiling-point, or molten metal.

Burns are classified by their depth, and the best practical system is that of Dupuytren.

1. Hyperæmia—merely redness of the skin with sufficient exudation to cause swelling and subsequent peeling of epidermis, but not enough to raise it in blisters. Scorching with a hot sun, if continued, will produce this, or a very temporary application of hot air or flame. Unless very extensive, it is not dangerous, but if it involves half the body the result is nearly always fatal.

2. Vesication.—Bullæ form, containing a more or less clear fluid which coagulates. The size they reach depends chiefly upon the thickness and toughness of the epidermis; one, for example, may ensheath the whole hand. These are chiefly due to scalds or the transient application of heated metal, and are more painful and much more serious than the former; but though the mark is often visible for years, owing to the way in which it changes colour on exposure, the surface of the skin and its various appendages are entirely restored.

3. Superficial destruction of the corium. This is difficult to tell from the second; one passes imperceptibly into the other, and a burn of the second degree always forms a ring of greater or less width round every patch of the third. Vesicles are not so prominent a feature, and if they are present they usually contain a turbid brownish fluid. The surface is yellow or grey, or transformed into a dark brown slough. The pain is much more severe, especially after the first two or three days when the dead surface is beginning to separate, and a certain degree of suppurative fever usually follows. The scar that is left is permanent; the whole length of the papillæ and the cells that line the depressions between them have been destroyed, so that the natural surface is never restored; but, on the other hand, contraction never takes place, differing in this respect immensely from the next.

4. Destruction of the whole thickness of the skin. It is naturally impossible to tell this from the preceding until the sloughs have separated and cicatrisation is beginning; indeed, the third may in places become deepened into the fourth by the suppuration that ensues in the course of repair. There is no vesication, the superficial structures are destroyed, the central area is covered with a hard, tough, dry eschar, surrounded by zones of the third and second degrees. The pain at first may be slighter, or perhaps owing to the severity of the shock the patient at first feels it less; but later, when inflammation sets in and the sloughs are beginning to separate, it

becomes very severe. The cicatrix is characterised by the most inveterate tendency to contract; if it is on the flexor surface of a joint, and is not checked by treatment, it may continue until no further distortion is possible.

5. and 6. In these the destruction is deeper still; in the former the muscles only are affected, in the latter the whole thickness of the limb. As a rule, burns of this description are local, involving only a small part of the body or of one of the limbs. Healing is always exceedingly protracted, and it is not uncommon for profuse hæmorrhage to take place about the time that the sloughs are beginning to separate.

CONSTITUTIONAL SYMPTOMS

These are divided into three stages corresponding to different periods.

1. *Collapse.*—Extensive burns, even if they are superficial, are followed by the most profound shock. In some the prostration is complete from the first; pain is not felt, there is only a sensation of intense cold and thirst. In others there is persistent restlessness, with vomiting or low delirium, and in children convulsions. The collapse may continue for twenty-four hours or even more, the pulse gradually growing weaker and weaker; or reaction may set in. If this is long delayed the prognosis is very unfavourable.

2. *Reaction.*—As the shock passes off the temperature begins to rise and fever commences, caused no doubt to some extent by the pain and the reflex irritation of the heat centre, but chiefly by the altered condition of the blood and the absorption of morbid products from the wounded surface. If the burn is thoroughly covered up, away from the air, so that the ends of the nerves are not irritated, and there is no putrefaction, the rise of temperature is only slight, and subsides in the course of a few days. If, unhappily, this is impracticable, as it usually is in extensive injuries, septic fever follows, the temperature rises higher and higher, and either sapræmia with some form of internal congestion proves fatal, or after a long illness the tissues gradually gain the upper hand, throw out a barrier of granulations and check further absorption.

It is in this stage that abdominal and thoracic complications, pleurisy, pneumonia, enteritis, duodenal ulceration, peritonitis, &c., are most common, although they are not confined to it. Sometimes the symptoms are characteristic, short hacking cough with rusty blood-stained sputa for example; more frequently there is nothing definite, merely a continued high temperature, with quick, feeble pulse, and rapidly failing strength.

3. *Suppuration.*—This is no more essential to the healing of burns than it is in the case of other wounds; a cautery plunged into a nævus, leaves a deep cavity, with blackened charred edges, which, if protected from the air, heal over without a trace of pus. In most cases, however, owing to the enormous extent of surface and the conditions under which burns occur, it is practically impossible to prevent the access of living organisms, and the surface of the granulations thrown out by the tissues around always melts away. In not a few this seriously increases the depth of the injury, the tissues that might have otherwise recovered yielding before the combined effects of septic decomposition and suppurative micro-organisms.

The stage of reaction passes into that of suppuration without any definite line; the transition is usually placed at about the end of the second week; the temperature begins to fall of a morning, and if no internal complication sets in, the continued fever subsides and becomes remittent. This continues until the granulating surfaces have healed. After a time the danger of visceral troubles diminishes, but hectic, exhaustion, amyloid disease and other complications that occur in connection with large suppurating wounds are always liable to follow.

Pathology.—Fully half the cases that die prove fatal from shock within the first forty-eight hours, the post-mortem appearances presenting nothing that is characteristic. In the second period, from the end of this time until suppuration has set in, congestion, or sometimes inflammation, of internal organs is often present. In the earlier part the brain is chiefly affected; later the thoracic and abdominal viscera suffer most; and associated with this in a certain proportion of instances (16 out of 125 collected miscellaneously) is a peculiar lesion, ulceration of the duodenum. This has been found as early as the fourth day; it is most frequent in the second and third weeks, but it may occur much later.

There is no really satisfactory explanation either for the congestion or the ulceration. The former has been assigned to reflex paralysis of the walls of the vessels; to paralysis of the heart from over-heated blood; to capillary embolism; to changes in the blood produced by evaporation from an extensive denuded surface; and to retention of poisonous nitrogenous compounds that are usually excreted by the skin. Except the first of these, however, none has much to commend it; the degree of congestion is not in any way proportionate to the extent of the injured surface; small burns are sometimes much worse in this respect than large ones; and burns on the trunk are always more liable to pulmonary and intestinal complications than others. The severity of the shock is probably the most important factor; its effects by no means disappear when the temperature rises; the vitality of the tissues remains depressed for many days; they no longer possess their normal power of resistance, and any fever-causing substance absorbed from the wound is sufficient to excite an attack of diffuse inflammation.

Ulceration of the duodenum is equally hard to explain. It is not connected with Brunner's glands. The ulcers are perfectly indolent, as if simply punched out, and are usually situated immediately below the pylorus, rarely beyond the bile-duct; there may be only one, or there may be several, either separate from each other and circular in shape, or fusing together. The margins are sharply cut, and the centre is deep, sometimes extending through all the coats into the pancreas, or opening up a large artery or the peritoneal cavity; sometimes, on the other hand, cicatrising over, showing that the complication is not always a fatal one. There may be very great congestion of the duodenum around, but it is not invariable, and they may occur after burns of any size, or in any locality, although they are more common when the trunk is involved. The most reasonable suggestion appears to be that they are due to the action of the gastric juice upon some part of the mucous membrane in which the circulation has been arrested by congestion or by embolism. It is urged in support of this that they are rarely found beyond the orifice of the bile-duct; but it is singular, to say the least of it, that the congestion or embolism should not also sometimes occur in the stomach. It may be present without symptoms of any kind, suppurative peritonitis setting in suddenly and proving fatal almost at once; or there nay be diarrhœa with melæna, epigastric pain, tenderness and vomiting of ark brown fluid.

Burns of the chest, abdomen, and head are much worse, both as regards ymptoms and complications, than those of similar degree upon other parts f the body. In children and old people the prognosis, as might be expected, s much more grave; but the factor that is of most importance in estimating he risk to life is the extent of surface. A deep burn, if it is limited, is often nly a local affection; a very superficial one, on the other hand, caused by nomentary exposure to intensely heated air or steam, if it involves a large rea, will almost certainly prove fatal from shock, or if the patient survives his, from subsequent internal congestion. When the face is much burnt here is always the danger that the mucous membrane of the larynx may ave been injured at the same time, and that œdema of the glottis and roncho-pneumonia will follow.

Treatment.—In a large, superficial burn, the first thing is to prevent he patient sinking from collapse; under the influence of the shock the temerature falls, the circulation becomes feeble, the amount of heat and energy roduced by the tissues diminishes, and death may ensue simply from the ailure of power. Warmth, stimulants, and opium are the chief remedies. The heat of the body must be economised in every way, pain relieved as far s possible, the heart prevented from failing, and the tissues supplied with iffusible stimulants which will help them for the time to do all that they an. If it can be managed, the patient should be placed at once, without waiting to take off clothes that are adherent, in a warm boracic bath, the emperature of which is carefully maintained; and provided the inhalation f the hot vapour is prevented by surrounding the neck with a macintosh or other waterproof material, he may be left in this for some hours until reaction begins. Meanwhile the burnt fabrics will float off or can be cut away, withut injury to the parts beneath or exposing them to the air. As soon as the pulse begins to recover, all the injured parts should be wrapped in many ayers of boracic lint or salicylic wool, and enveloped with a bandage, a ertain degree of soft compression being used. Carbolic acid is much too rritating for burns, and corrosive sublimate applied to an extensive surface would very probably prove dangerous.

Thirst may be relieved with milk and soda water, or very dilute acid rinks. How long stimulants are necessary must be determined by the ondition of the pulse, but care should be taken not to push them too far or o continue them too long; as soon as there is a distinct improvement in the rterial tone, small quantities of beef-tea should be given with them, and should gradually replace them; but, throughout, everything must be done to maintain the strength of the patient. The visceral congestion and inflammation that occur in the second period, that of reaction, are distinctly encouraged by everything that tends to reduce the already weakened reserve; and after this stage is passed, and suppuration has set in, the question of recovery or not often turns upon the balance that is left, and the way in which it can be economised.

Diarrhœa should be checked at once with opium and dilute mineral acids. Pulmonary complications must be met with ether and carbonate of ammonia. If vomiting occurs, it may sometimes be relieved by very minute doses of vinum antimoniale, or the stomach may be left entirely empty for a time, and nutrient enemata given instead. Bromide of potash is often necessary in cases in which there is delirium, or evidence of commencing cerebral congestion, and quinine, tonics, and especially iron, in the later stages, if the appetite is failing or the strength shows signs of giving way under the prolonged strain.

The local treatment depends upon the depth of the burn, but the principle is in all cases alike; protect the part thoroughly from the air, prevent decomposition, and change the dressings as seldom as possible.

In those of the first degree, in which the area is limited, the ordinary, domestic appliances, mashed potatoes, lead lotion, cold spirit and water, anything in short that is cooling and diminishes the hyperæmia, answers exceedingly well. Dry applications such as flour, Fuller's earth, &c., in many people cause a degree of irritation and of itching that is almost as painful. Flexible collodion or lead paint is very useful, especially on the body or where the skin is liable to friction from the clothes.

If blisters are present already they must be pricked, the fluid allowed to ooze quietly out and the epidermis gently replaced; but when the case is seen sufficiently early, an attempt should be made to check their formation by limiting the amount of blood going to the part; this may often be managed by investing the affected area at once with boracic lint (wetted with cold boracic lotion if the sense of smarting is very severe), and then with many layers either of a similar material or of wood-wool or salicylic wool. A flannel bandage is placed over the whole with a fair amount of pressure, and the part is well raised. The dressing should be left on as long as possible, and when it is necessary to change it, it should be allowed to float off in a bath. Carron oil (equal parts of lime water and olive oil) is a very favourite application, but the smell after it has been applied some little time is very nauseating; bicarbonate of soda (a saturated solution) is stated to relieve the pain more quickly than anything else, but though I have tried it in many cases, I cannot say that I have succeeded in persuading myself of its superiority. Zinc ointment answers well when the surface is of small extent, and the same may be said of vaseline, carbonate of lead ointment, resin ointment, and many others.

In burns of limited size but greater depth, the same principle must be adopted, but for these iodoform and corrosive sublimate can be used. If there appears to be a chance of drying up the sloughs and limiting the amount of exudation, the former is the better, freely sprinkling it all over, and then applying wood-wool over this. If, on the other hand, from its position, or from the length of time that has elapsed since the injury, and the amount of exudation that is present, this does not appear to be practicable, the part should be well irrigated with corrosive sublimate, or placed in a bath of it for a time and wrapped in boracic lint. In any case, whatever dressing is used for a burn, it should be left as long as it possibly can be, and the greatest care is required when changing it not to disturb the newly-formed epidermis.

Finally, in some very severe cases amputation is required, but this should not be thought of until the shock is past, and preferably not until the line of demarcation is distinct. Occasionally it is performed at a later period, either because of prolonged suppuration or because the limb, although it has been saved, is merely an encumbrance.

After the sloughs have separated the suppurating surface left requires the same treatment as other wounds, the only difference is that the granulations have an extraordinary tendency to become pale, flabby, and exuberant. This, which is in great measure due to the distance from the base, and the defective contraction of the deeper layers, is best kept in check with nitrate of silver. Either a lotion of three grains to the ounce may be used for the whole surface, or what answers better, the solid stick may be applied occasionally all round the margin. Grafting is usually necessary for the healing of large surfaces, but often it is very disappointing; rapid progress is made for a short time, and then suddenly the whole of the newly cicatrised area breaks down again. Every attempt, however, should be made to procure early cicatrisation; contraction cannot be prevented altogether in a burn of the fourth degree (except by covering in the whole granulating surface with fresh or vivified grafts, as already described under cicatrices), but the longer the suppuration lasts, the greater the amount of dense, contracting tissue that is developed.

Mechanical appliances are often required, partly to keep the injured surfaces at rest, but chiefly to prevent contraction. Splints, extending apparatuses, elastic bands, &c., must be adapted to the special circumstances of each case, and no general rules can be laid down for them, except that their action must be continuous night and day. I have known three days' respite allow such a degree of deformity to take place, that the former position was never thoroughly regained.

PART III

DISEASES AND INJURIES OF SPECIAL STRUCTURES

CHAPTER I

DISEASES OF THE SKIN

By J. Hutchinson, Jr., F.R.C.S.

It is well, before considering the various diseases of the skin, to define the chief 'primary lesions' which are met with in them, and to state the anatomical characters which are their foundation. The following are recognised by most dermatologists—

1. A *macule* or spot consists in an abnormal discolouration of the skin, confined to a limited area. There is no elevation of the affected part, and the colour may either disappear on pressure (*i.e.*, it may be due solely to congestion of the small vessels), or there may be abnormal pigment-deposit in or beneath the rete mucosum. We see examples of macules in a great number of skin diseases, for instance in some early syphilitic eruptions, in leucoderma, measles, &c. Not infrequently a macule is the result of a small hæmorrhage into the skin.

2. A *papule* is a small solid elevation of the skin, generally due to congestion and plastic exudation into the papillæ, around the hair-follicles, &c. The term papule is applied when the elevation is of any size up to that of a lentil, when larger the term tubercle is applied. Just as a carbuncle is practically a large furuncle or boil, so a *tubercle* is an exaggerated papule. It must be clearly understood that in speaking of tubercles of the skin no necessary association with scrofula or tuberculosis is intended; thus we use the term 'tubercular syphilide.'

Papules are met with in the various forms of lichen, in prurigo, &c.

3. A *vesicle* is a small elevation of the skin due to fluid (not pus) exuded between the rete mucosum and the horny layer. A *bulla* is simply a very large vesicle, and in both the contents frequently become purulent at a later stage of the disease. Good examples of vesicles are met with in eczema, herpes, and scabies, and in association with excessive sweating, when they are known as sudamina.

4. A *pustule* is a small abscess, the wall of which is formed by the epidermis; the contents may be from the first purulent, or, as already stated, the pustule may be a later stage of a vesicle. Sometimes a pustule is simply an inflamed gland, as in acne, or it may commence in the corium apart from any glandular structures. Pustules are seen in a great variety of skin diseases, the best examples being impetigo or porrigo, eczema, and acne.

5. A *wheal* is an elevation of the skin of various shapes and sizes, the margin being abnormally red or purple and the centre pale, due to œdema.

They are usually formed very rapidly and may disappear with equal rapidity, and they often recur. Pigment macules may be left behind after their subsidence (as in urticaria pigmentosa). Wheals are due to localised vascular disturbance; it is thought that spasm of the vein-walls may prevent absorption of the exuded lymph (Unna). Reflex nervous action is largely concerned in their production. Good examples are seen in erythema nodosum, and in urticaria.

These are the chief primary lesions in skin diseases; the various secondary ones, such as crusts, fissures, scales, ulcers and scars hardly need definition here. The tendency to leave scars is an important feature of some skin diseases, and often serves to distinguish those which involve the corium from those in which the epithelial layer is chiefly or solely concerned.

ECZEMA

This very common skin disease includes a great variety of forms and is due to very many different causes; it consists essentially in superficial inflammation of the skin attended with free cellular and serous exudation. The papillæ and rete mucosum are chiefly affected; papules, vesicles, pustules, and fissures are amongst its usual primary lesions, the most characteristic feature being a moist scaling or scabbing patch. It occurs in either an acute, subacute, or chronic form; in the latter the moist exudation is often absent, whilst marked thickening of the skin may be present. Dry eczema approaches psoriasis very closely, and sometimes it is only the position of the eruption that enables one to diagnose between the two. Eczema tends to affect exposed parts (hands, face, neck, and scalp) and the points of flexure (axillæ, bends of wrists, popliteal regions, &c.), in preference to the extensor surfaces of the limbs and trunk, which psoriasis selects.

Eczema is nearly always accompanied by a good deal of itching, and in severe and acute cases there may be considerable pain and constitutional disturbance. Starting sometimes as a patch of small size, eczema may spread rapidly over the whole limb or body, the eruption, so to speak, 'blazing up'; and this is one argument in favour of neglecting no pains to cure a single patch of the disease. Eczema has a marked tendency to be symmetrical, often recurs, and may affect patients of all ages. Eczema of children and infants has frequently the pustular form (porrigo, ecthyma, impetigo contagiosa), whilst in elderly subjects it is often of the very chronic and comparatively dry form. It is in the latter class that what is known as eczema rubrum or pityriasis rubra occurs; in this form the whole body may be covered with the eruption, profuse desquamation is present, and the patient's health may be very seriously affected. Eczema rubrum is very difficult indeed to cure, and not uncommonly ends fatally (if the whole body be affected).

Pathology.—The first stage of eczema is congestion and infiltration of the papillæ and rete mucosum with cells and serum; thus are formed patches of erythema, papules, and vesicles. The latter readily rupture, and the exudation is irritating to the adjoining skin, possesses the property of stiffening linen, and by drying with the cast-off epidermis forms the characteristic scabs or scales. Pustules of varying sizes are common, especially in children and where the skin is thin; whilst in certain situations (such as the palms and soles) the skin becomes greatly thickened and fissured, vesicles and pustules being the exception. This form is known as eczema rimosum.

The character of the eruption is often modified in other ways by its situation, and we may here note some of the chief varieties as affected by the site.

Eczema of the genital regions and around the anus may occur in infants from the irritation of decomposing urine, &c.; it is then most severe in hot weather, and sometimes leads to superficial ulceration. If occurring in the folds of the groins or axillæ, &c., it is called eczema intertrigo, and this form may be met with at all ages. Large areas of intense congestion, with perhaps but slight desquamation, are the characteristic feature in this position. Again, eczema of the genitals is seen sometimes with diabetes mellitus, and dry well-defined patches are met with (especially in hot countries), due to a cryptogam (eczema marginatum).

Eczema of the buttocks in young children sometimes simulates a syphilide; the patches of the latter, however, do not 'weep,' are darker (more coppery) in colour, and frequently have a gyrate arrangement. Eczema of the legs is frequently associated with varicose veins or occurs around a chronic ulcer; in its idiopathic form it is seen here most often over the popliteal space. Iodoform dressings applied to an ulcer frequently produce acute eczema. Impeded blood-return (due, for instance, to prolonged standing at work) is a powerful agent in its production and must be corrected by the use of elastic stockings, rest, &c., in order to effect a cure.

Generalised eczema of the trunk is often associated with marked debility, both in children and adults, and therefore requires a tonic or restorative measure of treatment. At the same time it may be set up in perfectly healthy individuals by profuse sweating or sudden exposure to chill, or by the irritation of flannel underclothing. It is a frequent accompaniment of general pediculosis, in which case the excessive pruritus at night should lead to the correct diagnosis being made.

Eczema intertrigo of the breasts is especially met with in women with fat pendulous mammæ. *Eczema of the nipple* is a fertile source of trouble during lactation. This form requires to be distinguished from 'Paget's disease,' or chronic eczema of the nipple, which occurs independently of suckling, lasts an indefinite time, and is noteworthy as being a precursor of scirrhus of the breast.[1] It is a decidedly rare disease. Eczema of the hairy parts of the face is known as *sycosis*, and is characterised by the formation of pustules around the hair-bulbs, and by marked infiltration and stiffening of the suroundinig skin. Like eczema marginatum, there is a parasitic or cryptogamic form of sycosis, but this is comparatively rare in England.

Eczema of the eyelids, or *blepharitis*, is a frequent sequel of measles, and is also most common in strumous or ill-nourished children. The same may be said of eczema of the face, ears, and scalp, though when affecting the latter the irritation of pediculi is a common cause. The eruption there is at its worst generally in the occipital region, and enlarged glands or glandular abscesses are frequent complications. The presence of lice or their ova in the hair is easily detected, however profuse the scab-formation may be.

Finally, eczema of the hands is commonly due to some local irritant, such as strong solutions of soda (washerwoman's eczema), the presence of the itch-insect, the irritation of sugar and of exposure to great heat (as seen in bakers), or to cold winds, &c. Chronic dry eczema of the palms requires to be carefully diagnosed from true palmar psoriasis due to syphilis; in the latter oval or crescentic patches of dusky infiltration are met with; in the former, deep cracks or fissures and hard scaly areas of skin.

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[1] Recently M. Darier, of Paris, has discovered that 'Paget's Disease' is due to an animal parasite—the coccidium oviforme. I have published confirmatory evidence in the Pathological Transactions for 1890.

As regards the causes of eczema, the influence of local irritation, especially on tender skins or those predisposed by hereditary influence or general debility, is one of the chief. Improper diet plays also an important part in some cases, and the gouty diathesis is often blamed. In some patients the free use of milk as an article of food may produce eczema, though in children with 'scrofulous eczema' it is a valuable agent in treatment. The irritation of teething in infants undoubtedly sets up eczema in some cases, and to vaccination has been (often wrongly) ascribed the same result.

Treatment.—The detection or removal of any possible irritant is the first measure to be taken, and it must be remembered that the mere act of washing with ordinary soap may be very prejudicial to a patch of eczema. As a general rule the patient should gently remove the scabs by means of olive oil, or weak gruel, or bran water, and if soap be used at all it should be in the form of Unna's super-fatted soap, or Roberts's vinolia. If the scab be very thick, a poultice will be found the easiest means of effecting its removal. An eczematous patch should be protected during exposure to the air by the free use of some non-irritating ointment (such as Ung. Plumbi Acetatis or Ung. Zinci Benzoatis), and if, for instance, it affects the hands, gloves should be worn over the application. The treatment differs greatly with regard to the acute and chronic stages of eczema. In the acute form, where free exudation is present, soothing lotions of lead salts (e.g., Liq. Plumbi Subacet., ʒj ad. Oj, made, if preferred, with milk instead of water), or ointments containing lead or zinc salts, are the best; in the chronic form, tar lotions and ointments containing mercury and tar prove the most efficient. Thus, for instance, in a case passing into the chronic form we order:

Liq. Carbonis Detergentis . . .	♏v
Liq. Plumbi Subacetatis . . .	♏v
Hydrargyri Amm̄. Chlor. . . .	gr. v
Vaselini	℥j

and a suitable lotion for a very chronic case (to be applied continuously as a water dressing) is one containing half to one ounce of the Liq. Carb. Det. to the pint. Tar preparations sometimes irritate, and their strength must be graduated to the individual case.

The Ung. Hyd. Nit. Dil. is an extremely valuable application for chronic eczema, especially of the eyelids or other parts of the face. The Ung. Hyd. Oxidi Flavi is another good preparation, but the ammonio-chloride ointment should never be applied over a large surface. The Ung. Bituminis Co. (solution of tar, one drachm to the ounce of vaseline), and glycerole of acetate of lead, are both frequently used in the treatment of eczema.

With regard to the constitutional treatment, eczema in strumous subjects is nearly always benefited by the use of cod-liver oil, syrup of phosphate of iron, &c., and any errors of diet should be corrected. If definitely connected with gout, colchicum may be prescribed with advantage, and in very chronic dry cases (those approaching psoriasis in appearance), arsenic does good. In the acute and subacute forms it should not be given.

Constipation should be guarded against, and frequently tonics—especially iron and nux vomica—are valuable aids in treatment.

Residence at the seaside rarely suits cases of eczema, and, as a rule, warm inland resorts are the best.

Isolated, very chronic, patches of eczema, such as are seen on the palms, require special local treatment. It is essential to soften and remove the dense layers of epithelium before applying any ointment, and in salicylic acid we have a very good means for effecting this. A solution (ten grains to the ounce) may be applied as water dressing under oiled silk, or the salicylic acid plaster, renewed every two days. In a short time the thickened epidermis may be rubbed off, and subsequently the Ung. Bituminis cum Hydrargyro used.

PSORIASIS

This is an extremely chronic, relapsing, dry form of skin disease which tends to affect characteristic localities; the fronts of the knees, backs of elbows, scalp, and trunk being the chief ones.

Pathology.—There is congestion and slight cellular infiltration of the corium, thickening of the rete mucosum, and the formation of layers of white epidermic scales which peel off more or less profusely in flakes. If all the silvery flakes be removed by the finger-nail from a patch of psoriasis, small, bleeding spots are laid bare. The patches have an almost indefinite duration, and if they are cured for the time by treatment, leave reddened areas behind. The true cause is quite unknown, usually the patient is in normal health when the psoriasis appears, a tendency to it is hereditary, and it has been asserted to be inoculable.

Symptoms and Diagnosis.—Psoriasis patches vary much in size, on the tips of the knees and elbows especially we meet with very large ones. On the scalp there is usually profuse desquamation, but typical silvery patches are not often seen in this position, and the disease might be mistaken for dry eczema or seborrhœa. But nearly always other undoubted patches of psoriasis will be found on the extensor surfaces of limbs or trunk. Psoriasis does not itch nearly so much as eczema, and unless irritated by some application or by scratching, there is at no time any moist discharge.

It may develope at any age after the first few years and is common in young adults; it frequently appears during the spring or autumn. Syphilis may produce an eruption which closely simulates it, but the peeling is generally scanty, the surrounding congestion has a darker tint, and other evidences of syphilis will be present in most cases. In true psoriasis there will probably be the history of several relapses. If the patches be situated round the anus or on the scrotum they may become sodden with moisture, and then imitate roughly syphilitic condylomata, but this is not common.

When psoriasis is diffused the nails are commonly affected, becoming rough and greatly thickened, and occasionally the disease is limited to the hands and feet. But as a rule, what is called palmar or plantar psoriasis is either chronic eczema or a tertiary syphilide.

Treatment.—If any derangement of health can be detected, it may require tonic or other treatment, but, as already stated, the patients as a rule are in vigorous health at the time the eruption appears. There is one drug which if taken persistently has a marked effect alike in modifying the disease and preventing relapses, namely, arsenic. Liq. Arsenicalis ♏v, or the same dose of Liq. Sodæ Arseniatis, should be given twice or thrice daily in water after meals, and the dose may be increased up to ♏xv or ♏xx if the drug is doing good. It needs, however, to be taken for long, and the possible toxic effects should not be forgotten. The chief ones are conjunctivitis, gastric pain and dyspepsia, diarrhœa and colic. There is also little doubt that a protracted course of arsenic has led to paraplegia, of which the earliest symptoms will be unsteadiness of gait. Local treatment should be combined with the administration of arsenic. The heaped-up scales should be removed by hot water and scrubbing, by the use of salicylic acid preparations, alkaline baths, &c. The Ung. Bituminis Co., Ung. Acidi Pyrogallici (ʒss. ad ℥j vaselini), and Ung. Acidi Chrysophanici (gr. x or gr. xv ad ℥j) are amongst the best applications. Chrysophanic Acid is one of the most powerful, but it stains the linen, &c., yellow, and sometimes causes much congestion and irritation, hence caution is required in its use. Dr. R. Crocker recommends Ol. Pini Sylvestris, diluted with olive oil and with some oil of lemon to cover the smell. Tar lotions and baths are also valuable in the treatment of this obstinate disease.

LICHEN

The essential feature of this disease is the existence of papules, sometimes developing around the hair-bulbs, sometimes independent of them. The former variety is often met with, especially on the extensor surfaces of those with rough skins, and may neither produce any irritation nor call for any treatment. Lichen papules of distinctly inflammatory nature, usually itching, occurring by preference on the trunk and extensor surfaces, and tending to persist for a considerable time, may be due to various causes. One form occurs as a manifestation of secondary syphilis, often in combination with some other variety of syphilide (*e.g.*, psoriasis). Another, and a very obstinate form to treat, develops in early childhood (this used to be called strophulus or red-gum). Another, much rarer one, is met with in association with scrofula (enlarged glands, &c., in children) and is known as *lichen scrofulosorum*. One characteristic variety occurs in crescentic or horse-shoe patches near the middle line of the trunk (both front and back), it is called *lichen marginatus*. *Lichen ruber* or *lichen planus* is yet another form, in which the papules are larger than in the other varieties, are flat-topped, purplish-red in colour, and may affect any part of the body except the face and head. There is certainly some relation between lichen planus and psoriasis, and the same internal remedy (arsenic) is valuable in the treatment of both.

In all the forms of lichen there may be slight desquamation associated with the papules, but there is no tendency to 'weep' as in eczema, nor to form pustules, unless irritated by scratching, &c.

With regard to the diagnosis, lichen planus may readily be mistaken for a syphilide, especially if the colour of the papules approaches a brown or copper hue, but probably the history of its long persistence, the absence of any other syphilitic symptoms, and the greater amount of itching will lead to a correct conclusion. It should be remembered that in some cases of lichen planus, the tongue and mucous membrane of the cheeks are affected with white raised patches, and this might add to the difficulty of distinguishing the two. Lichen planus is practically confined to adult life, and is more common amongst the well-to-do classes than the poor.

Lichen marginatus affects the same regions as tinea versicolor, but microscopic examination of a scraping from the patches will prove the absence of cryptogam in the former, and its presence in the latter.

Treatment.—The lichen of young children is best treated locally by the use of weak tar ointment or lotion (Liq. Carbonis Det. ♏v ad Vaselini ℥j, or ♏x to the ounce of water) and the avoidance of irritating soaps.

Lichen scrofulosorum requires the internal administration of cod-liver oil and good diet. Lichen marginatus is probably to a large extent a 'vest-eruption,' for instance, it may be set up by wearing the same vest night and day. For it purely local treatment is required; frequent changes of under linen, the use of a silk vest under the flannel one, and the application of an ointment containing fifteen grains of salicylic acid to the ounce will rapidly effect a cure. Lichen planus is generally amenable to arsenic, which should be given in the same doses as for psoriasis; locally, tar baths or ointment are useful.

The amount of itching met with in the different forms of lichen varies much; where this symptom is especially marked and obstinate the term prurigo is applied. Especially if neglected at first, it may become inveterate, and, owing to the scratching, pustules and fissures may be freely produced. In young children, prurigo may follow varicella; in elderly people it is often simply due to the irritation of pediculi (*see* Parasitic Diseases of the Skin).

Prurigo or lichen-prurigo is also met with in patients with a dry harsh skin, relapsing every summer or winter, and leading to considerable pigmentation of the affected areas of skin. The treatment is the same as that of lichen, with the addition that quinine given internally has sometimes a most beneficial effect. The severity of the itching at night may call for the use of sedatives (syrup of chloral, &c.).

PEMPHIGUS

In this disease large vesicles or bullæ are formed on various parts of the body, without any tendency to symmetry, but with a strong one to occur in successive crops unless checked by treatment. The bullæ may be situated on a somewhat congested base, contain albuminous fluid with leucocytes (often mixed with blood), and readily rupture. The causation of pemphigus is quite unknown; its subjects may appear to be in good health at the time of the outbreak, though if severe it leads to marked debility. It affects young subjects more often than elderly ones, and males more than females; cases with a fatal ending are usually seen in patients at the extremes of life. No part of the body is exempt from the development of the bullæ, which vary greatly in size up to a few inches in diameter. They are found in the malpighian layer of the epidermis, and therefore leave no scars, though for some time an oval or round, congested or pigmented patch marks the site of a former bulla.

Although the cause of pemphigus remains a mystery, the treatment is in most cases very successful, consisting simply in the internal administration of arsenic. Three to five drops of the Liquor Arsenicalis should be given thrice daily, and the dose gradually increased if necessary up to ten or fifteen drops.

If begun before marked cachexia has been produced, this treatment nearly always effects a speedy cure. Any simple protective application (*e.g.*, zinc oxide and starch powder on lint) may be used locally.

There are several forms of skin disease, not true pemphigus, and not yielding to arsenic, in which bullæ are produced. Infants with congenital syphilis may present a bullous eruption, which is considered as a very grave symptom, though recovery may ensue. In pregnant women occasionally a herpetic or bullous eruption, attended with considerable itching and perhaps rise in temperature, may develope in various parts of the body, subsiding after delivery. The term herpes gestationis is applied to this form.

Cheiro-pompholyx is a rare affection in which bullæ are formed on the hands—particularly between the fingers—usually in young adults, they are asserted to be in connection with sweat-glands or ducts, but this is doubtful. No specific treatment is known, but the eruption usually subsides after a time, showing a tendency to relapse.

In patients with delicate skins—especially young children—the irritation of the acarus scabiei may cause large vesicles or pustules. Some drugs, and particularly the iodide and bromide of potassium, may produce a bullous eruption on limbs and trunk. Thick crusts are formed by the drying of the contents of the bullæ, and if the drug be continued large granulations may be formed at their sites. Such cases are rare and probably depend upon peculiar idiosyncrasy to the drugs, as they do not specially occur in those to whom large doses are being given.

LUPUS

A very chronic, destructive, and scar-leaving form of inflammation of skin and mucous membranes, commencing in the corium proper. Leaving apart the form known as lupus erythematosus, we may say that common lupus begins almost invariably at an early period of life, often during childhood, and cases starting after the age of thirty are very exceptional. Its subjects may be at the time of the outbreak in otherwise good health ; it is, however, asserted that they are often the offspring of phthisical parents, and in some cases they may themselves develope later tubercular disease. It may be admitted that lupus, if not a tubercular affection of the skin, is closely allied to it, and Koch has proved that the bacillus tuberculosis is sparingly present in nodules of lupus.

The tendency of a patch of lupus is to spread at its edges as well as to invade the deeper parts and the adjoining mucous membranes ; spontaneous cicatrisation may occur, but generally the disease lasts indefinitely unless treated. The early recognition and prompt treatment of lupus is most important in preventing permanent disfigurement.

The first stage of lupus consists in the formation of small yellowish-brown or pink nodules, of softer consistence than the healthy skin. These are found to consist of small-celled infiltration of the corium, with scattered giant-cells (in which the bacillus of tuberculosis may be occasionally detected). The nodules have a semi-translucent or 'apple-jelly' aspect ; the next stage being the breaking down of the centre and the formation of a pustule, succeeded by superficial ulceration or desquamation. There is often an extensive scabbing or eczematous condition over a lupus patch, especially if irritated by exposure to wind, cold or wet weather, &c. Finally, the lupus nodule may cicatrise, the scar formed being usually prominent, dense, and often of a pinkish hue. But complete spontaneous subsidence of a lupus patch is rare; whilst one part is breaking down or cicatrising, fresh nodules are forming in the neighbouring skin, or perhaps at some distance from the original site, and in a single patch all the stages of apple-jelly-like growth, pustules, eczematous condition, ulceration and scarring may often be observed. If situated near a mucous membrane, *e.g.*, of the mouth or nose, lupus tends to invade it, forming large soft granulations, but not often presenting the typical yellowish-pink or brown nodules seen on the skin. The lips, gums, palate and even the pharynx and aperture of the larynx may be invaded, the septum and cartilages of the nose destroyed, or great deformity (ectropion and destruction of the lids) produced by the disease invading the conjunctiva.

The disseminate patches of lupus seen occasionally on various parts of the body are no doubt due to blood-infection from a single original patch. Lupus rarely begins as a primary growth in the mucous membranes, but occasionally it does so, for example, perforating the septum nasi by a solitary ulcer. The lymphatic glands are not infrequently secondarily enlarged, and may break down into the ordinary strumous glandular abscess. So-called lupus of the genitals (particularly of the vulva and vagina) is nearly always due either to syphilis or epithelioma. One character is constant to lupus, wherever situated, a very slow course, rebellious to treatment and tending to relapse again and again at intervals of months or years. There is also a special liability to the development of epithelioma in an old lupus patch, the cancer being then of a most virulent and destructive type. In connection with this tendency it is worthy of note that epithelial down-growths may frequently be seen in sections of recent lupus patches, and in fact it is difficult to tell such sections from those of true epithelioma. When lupus affects a part of the body covered with thick epithelium (*e.g.*, the feet), warty growth is a prominent feature, the soft nodules being entirely absent. What is known as verruca necrogenica, a condition seen on the hands of those who have to handle dead bodies (surgeons, butchers, &c.), is probably a form of lupus, microscopical examination showing the same structure, though there is not the same tendency to advance and destroy the tissues as in the ordinary form of the disease.

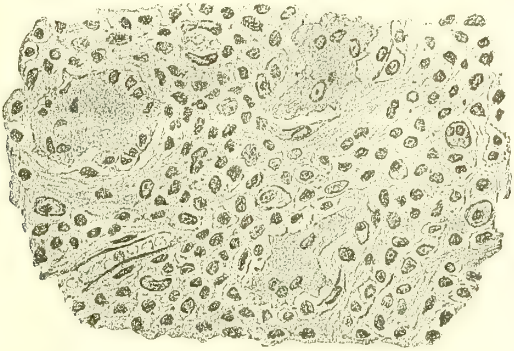


FIG. 24.—Section from lupus of the nose (× 350 diam.) Giant-cells are seen with cell-infiltration.

Diagnosis.—Bearing in mind the origin at an early age, the inveterate tendency to persist and to spread, the scarring left by the disease, and the usual presence of the apple-jelly-like nodules at some part of the patch, the student will have little difficulty in recognising most cases of lupus. The deposit of lupoid growth may sometimes be very small as compared with the scab-formation and scaling of epidermis, and thus simulate an eczema, but the latter disease never leaves scars. The greatest difficulty arises in telling some cases of tertiary syphilis (whether acquired or inherited) from lupus, and the term syphilitic lupus is a convenient, but not perhaps accurate, one for these cases; the following points will generally lead to a correct diagnosis:—

1. The patches of 'syphilitic lupus' tend to have a crescentic or horse-shoe outline, and are more commonly widely separated from each other than those of true lupus.

2. The tubercles or nodules are of a browner-red colour and firmer consistence than those of lupus. 'Apple-jelly' deposit is never seen in syphilis.

3. Syphilitic lupus when due to the acquired disease, commonly starts later in life (*e.g.*, from thirty to fifty) than true lupus, though, of course, there are often exceptions. When due to inherited syphilis the disease tends to be rapidly destructive, and is often accompanied by necrosis of the adjoining bones (*e.g.*, palate and nasal bones). In fact the latter form of the disease is of the nature of phagedæna, and requires prompt local and constitutional treatment to arrest its progress (cauterisation with acid nitrate of mercury and the administration of iodide of potassium and mercury). Inherited syphilitic lupus will eat away in a week or two as much tissue as ordinary lupus will take months or years in destroying.

4. The presence of other symptoms of syphilis, the polymorphism of the skin-disease, the history of acquired or inherited taint, will be of value in assisting the diagnosis. For instance, I recently treated a young man who had been supposed to be affected with ordinary lupus of the mouth, destroying within a short time most of the soft palate. The history of an attack of interstitial keratitis (from which there still remained nebulæ) pointed to the syphilitic origin of the disease, a diagnosis confirmed by the rapid destruction of parts which had occurred, and the great improvement which ensued under specific treatment.

Whenever the diagnosis between syphilis and lupus cannot be made, a careful trial of mercury and iodide of potassium should be carried out for a few weeks, remembering, however, that both these may occasionally fail in spite of the disease being syphilitic, local treatment by cauterisation and the use of iodoform being then required.

It may be here stated that there is not the slightest evidence of true lupus depending upon remote syphilitic taint, as has been asserted by some writers.

Treatment.—Whilst constitutional measures—cod-liver oil, good diet, and all means likely to improve the general health should not be neglected, local treatment is always needed to effect a cure. This consists in destroying the soft lupus nodules by scraping, cauterisation, or the action of certain chemical destructives.

1. *Scraping.*—This is best performed (nearly always under an anæsthetic) with Volckmann's sharp spoons, various sizes of which are employed. The spoon is used vigorously wherever there is any sign of the lupus nodules,

d particularly at the margin of a patch ; it has no effect upon normal skin scar-tissue. After scraping, the fine-pointed actual cautery is often applied each excavation made, or pure carbolic acid may be cautiously used with small brush. The sores are subsequently dressed with vaseline, boracic id ointment, &c., and if all the lupus-tissue has been destroyed they heal rly rapidly (of course leaving scars).

2. *Destruction by chemicals.*—The use of pure carbolic acid as an ad-nct to scraping has been alluded to ; it is supposed that the pain of the plication is diminished by subsequent free dusting over with powdered rbonate of soda. Acid nitrate of mercury may be applied with success to ry small lupus nodules, best on a sharpened piece of wood which is thrust ght into them. Chromic acid fused on a probe is recommended by Jame-n for the same purpose. Both methods cause a certain amount of pain, t this is insignificant compared with that produced by chloride of zinc d potassa fusa, two caustics formerly recommended but now deservedly andoned. Strong lactic and salicylic acids have lately come into use ; both ve a marked preference for the lowly-organised lupus-tissue over the althy skin. Salicylic acid is used in the form of a plaster spread on uslin, the plaster containing from 20 to 50 per cent. of the acid mixed with easote (which deadens the pain). The application is renewed twice a day til the lupus nodules have broken down and suppurated freely, when some mple ointment is applied. This salicylic-creasote plaster was devised by nna, and is known by his name ; in commencing the treatment the weaker rength should always be used. Whichever method be adopted, great tience is requisite in the treatment, which usually requires to be repeated veral times at intervals before a cure can be effected, and it must be ad-itted that in some cases (especially if the mucous membranes are much volved), none can be hoped for. But the tendency of lupus to cause irre-ievable deformity, as well as the danger of epithelioma supervening, will courage the surgeon to persevere in one or other of the methods of treat-ent recommended.

LUPUS ERYTHEMATOSUS

This disease, being much rarer and less amenable to surgical treatment, quires only brief notice here. Like lupus vulgaris, its pathology consists small-celled deposits in the corium (though it is doubtful if giant-cells or acilli are ever found), and it has a similar very chronic course. But in pus erythematosus abnormal vascularity of the patches is much more arked, there is hardly any destructive tendency, symmetry is constant from e first, the disease begins later in life than does common lupus, and the cal treatment of the latter is here not suitable. Further, it may be noted at lupus erythematosus has a special predilection for certain parts, namely e nose, cheeks, ears, and backs of the hands ; and the sebaceous glands re especially involved in the disease as well as the smaller blood-vessels. here is the same tendency to leave scars as in lupus vulgaris, but they are ss conspicuous. Not unfrequently the patches of lupus erythematosus ssume the bat's-wing shape—the body being represented on the nose, the ings on the two cheeks, whilst smaller patches exist inside each concha of he ears. They present a reddish or brown colour, a thickened edge, and ilated capillaries or small veins, and dry, eczematous spots, are to be noticed t various parts of the patch.

The disease is more common in women than in men, and especially in those liable to chronic dyspepsia and flushing of the face, or with feeble circulation, or prone to chilblains. It seems to be occasionally started by an attack of facial erysipelas.

Treatment.—This is very unsatisfactory, the long-continued use of weak tar ointment and lotion, or of the oleate of mercury ointment being perhaps the best. Pure carbolic acid may be applied to the most prominent parts, or the fine-pointed actual cautery if the vascularity is very pronounced.

ACNE

This very common disease depends upon an inflammation of the sebaceous glands, with obstruction to their ducts; it develops frequently at or soon after puberty, especially in those with thick coarse skins and abundant sebaceous glands. Its favourite localities are the face, back of the shoulder, and sometimes the chest. Any cause of lowered general tone, such as indigestion, constipation, sexual excesses, and want of exercise, may assist in producing acne, but its direct relation with the genital system has probably been greatly over-estimated, idiosyncrasy, especially as to coarseness of skin, being the most important factor. The simplest form consists in distension of the sebaceous glands with secretion, small pimples being thus formed with commonly a black spot at their apex—this is the orifice of the gland blocked with dirt. By pressure the contents can be emptied, the thickened coil of sebum resembling a small worm. Added to these comedones there is often some congestion, and in the more severe cases the glands inflame, producing miniature abscesses which ultimately leave scars. The surrounding skin is rarely of a healthy aspect, but is thick, greasy, and pasty-looking. If the abscesses and resultant scars are larger than usual the term acne indurata is employed, whilst that of acne varioliformis is given to those cases (usually in patients of adult life) in which the absence of comedones and the close resemblance of the pustules and scars to those of small-pox are the distinguishing features.

Acne rosacea bears much the same relation to common acne that lupus erythematosus does to lupus vulgaris; distension of the smaller blood-vessels is a prominent symptom, the nose and cheeks are the ordinary site, and it comes on at a much later period in life than the common acne. The so-called 'grog-blossoms' are due to acne rosacea, there being in them actual hypertrophy of connective tissue.

The diagnosis of acne usually presents no difficulties, though some cases of syphilitic eruption closely resemble it, especially the form known as acne varioliformis. The scars left by severe acne may simulate these due to small-pox, but the former are usually confined to the face and upper part of the trunk.

Workers in tar not infrequently develop acne, and bromide of potassium taken internally often brings out the eruption.

Treatment.—The constitutional treatment of acne must be based upon the detection of any cause which seems to favour its development in the individual case. Temperance as regards stimulants is especially necessary in acne rosacea. Constipation, defective menstruation, strumous tendency, sexual excesses, may each demand appropriate treatment; whilst errors in iet, and especially too large a consumption of meat, may need correction. n aperient iron mixture is often useful. As regards local treatment, frequent eaming and bathing the affected parts with hot water and the use of potash oap are important, whilst the matutinal cold bath will aid in giving tone the skin.

The plugged sebaceous glands may be emptied by means of a watch-key small curette every evening, and then an ointment containing precipitated ılphur (one drachm to the ounce) applied. Pure liquid carbolic acid painted ver the inflamed points, and then covered with collodion, often aborts the ıstule-formation. Perchloride of mercury (½ grain to the ounce) and sulphur 5 grains to the ounce of water, suspended with glycerine and spirits of ine) are both used as lotions in acne.

Severe cases of acne rosacea, which do not yield to careful dieting, the voidance of stimulants and exposure to excessive heat or cold, and the local se of pure carbolic acid and collodion may require the actual cautery or ven excision of parts of the hypertrophied skin.

The acid nitrate of mercury is a valuable but painful application, somemes used both for acne rosacea and acne vulgaris.

BOILS AND CARBUNCLES

There is no reason for separating these two forms of cutaneous and subıtaneous sloughing abscess, since both may be set up by the same general ıuse, the only real difference being that a furuncular abscess or boil disıarges its contents by a single opening, a carbuncle by several (which often ter coalesce). And several other purulent affections of the skin are of the ıture of boils, for instance the common styes of the eyelids, a superficial rm of whitlow, and the large pustules which, occurring usually in parts with ick skin, are known as ecthyma. There is reason to believe that all these runcular abscesses are due to the presence of a micrococcus, and their disıarge is certainly contagious (*i.e.*, it may produce similar abscesses in the eighbourhood of the primary ones).

A variety of debilitating causes may lead to an outbreak of boils, deficient improper food, the hydropathic treatment, &c., and they are not infreıently met with during convalescence from a severe fever (especially phoid). Training for athletic purposes, if the change of life is marked and dden, often produces them; and a too vegetarian diet may have the same sult. Work in the dissecting or post-mortem room occasionally causes eir development, and the connection between diabetes mellitus and carıncle was long ago pointed out and indeed over-estimated. Certain parts the body, speaking generally those in which there is a dense or coarse bcutaneous layer, are especially liable to the development of boils and carıncles. The back of the neck and trunk, and the buttocks are the favourite tes, though the external meatus of the ear, the hands, and feet are not ıcommonly affected. The features of both are too well known to need deription, but it may be noted that throbbing pain is almost a constant mptom until the pus and broken-down cellular tissue are given an exit. he extensive separation of sodden epithelium over and around a carbuncle also noteworthy. Sometimes boils abort, that is, never pass beyond the flammatory stage, and this is most likely to occur if they are protected from external irritation by the use of thick plaster as soon as they are recognised. The friction of a collar may localise a boil on the neck, that of a hard seat in rowing may produce one on the buttock, &c.

Diagnosis.—It is occasionally a question whether a superficial abscess with a central slough is of carbuncular or gummatous nature, but the rapid course of a carbuncle and the severe pain that attends it will usually suffice to decide the matter without going into the history as to previous syphilis. The ulcer left after the slough has come away is ragged and somewhat undermined at the edge.

Treatment.—If seen early a boil should be protected by thick plaster (a small central hole being made) and any friction of the clothes should be guarded against. A saline aperient should be given, and such dietetic or tonic treatment adopted as is indicated by the individual case. Painting tincture of iodine over the inflamed spot and the injection into it of a few drops of strong carbolic acid solution are both said to cause resolution in some cases, but generally it is advisable to hasten suppuration by warm fomentations, the most cleanly being an antiseptic poultice (carbolic acid lotion—1 in 40—on lint, or boracic lint applied moist under oiled silk). These antiseptic fomentations are much better than the linseed poultices, which have a decided tendency to bring out a crop of smaller furuncles around the primary one. If there is very great pain, or if the suppurative process appears to be spreading, an incision should be made, the relief which follows the outlet of pus being very great. The old free crucial incisions are pretty much abandoned. When all slough has separated a very good dressing is the Ung. Resinæ.

Sulphide of calcium (gr. j daily in pills) and yeast are both said to have some mysterious effect in preventing or checking the development of boils, styes, etc., but the evidence is not very satisfactory. Lately it has been recommended to treat carbuncles, if seen fairly early, by making an incision and scraping and squeezing out the purulent and necrotic centre, subsequently dressing the sore with iodoform or carbolic solution. This method, though painful, appears to hasten the healing and perhaps to prevent the spread of the carbuncle.

ULCERS

Any sore left by the destruction (gradual or sudden) of the superficial parts of skin or mucous membrane is an ulcer, the process either starting from the surface and extending to the deeper parts, or *vice versâ*. An ulcer, for instance, may begin as a small pustule, or in the centre of a patch of eczema, or it may arise in the sloughing out of a gumma or carbuncle. In deciding the nature of an ulcer we have to consider its site, shape, depth, the character of its edge, the surrounding skin, and its base or floor. It must not be supposed, however, that each variety of ulcer has its own peculiar features, and that we can always tell the cause by careful inspection of the sore alone (though this will in some cases suffice). For instance, some tertiary syphilitic ulcers may closely simulate rodent or epitheliomatous sores, or they may be practically indistinguishable from ulceration due to lupus, or even that resulting from a carbuncle.

Certain terms are used in describing ulcers, independent of their causation, of which the following are the chief.

A *chronic* ulcer (which is seen so commonly in the lower third of the leg) characterised by its indolent progress, hard congested edge and unhealthy ase, *i.e.*, unless healing under treatment no well-formed granulations are resent. Such an ulcer may take on, from neglect and the irritation of de- omposition, the *sloughing* process. The term *phagedænic* is applied if the lcer steadily spreads, but without the formation of large sloughs, and this ature is almost invariably due to syphilis.

An *eczematous* ulcer is one in which the main features of the disease are iose of eczema, the ulcer being comparatively superficial, but usually itensely irritable. It is surrounded by pustules and 'weeping' desquamat- ig skin.

The terms *congested* and *inflammatory* ulcers will be readily understood; ie name *varicose* ulcer is inappropriate, since it is not the ulcer itself but ie tissues around that present the varicose veins.

Since the life or death of the tissues depends chiefly upon a constant supply f healthy blood and its free circulation, with the removal of waste products by he lymphatics, it is obvious how large a share circulatory defects are likely o have in the production and perpetuation of ulcers. Impeded arterial upply, as after ligature of a main artery of a limb, or in senile gangrene, and enous obstruction of all degrees, afford examples. In old-standing infantile aralysis the circulation of the affected limb becomes very feeble, and most itractable ulcers are liable to form. Passive congestion from prolonged tanding is a very frequent exciting cause of ulcers of the legs, especially in nd after middle life.

Vitiated conditions of the blood, as in syphilis, scurvy, &c., are also ommon causes, and simple anæmia may help in producing ulceration. The oss of vitality of the tissues that comes from old age must be mentioned 'aralysis of a sensory nerve may be followed by ulcers in the affected area, artly, no doubt, due to the action of irritants, such as long-continued pres- ure, partly perhaps to a 'trophic influence.'

The common forms of ulcer met with in practice are the following:—

1. Syphilitic Ulcers

Omitting the primary chancres, these are of two chief varieties—that due o the breaking-down of a gumma, and the serpiginous tubercular form. No art of the body is exempt, though certain regions are especially liable, such s the upper third of the leg, the neighbourhood of the knee-joint, over the ternum and the skull.

In the case of the gummatous ulcer there will be the history of a (fre- uently painless) lump forming, the skin over it becoming congested and reaking down, and of the exit of a slough which is aptly compared to sodden vash-leather. The sore left is rounded, with inflamed margin and sharply ut or punched-out border, and the characteristic ashy-grey slough is often een in the cavity of the ulcer. Not infrequently the slough has been greater han the amount of skin destroyed, *i.e.*, the edge will be undermined, but iardly ever to the same extent as a true scrofulous or tuberculous sore. After healing has resulted a thin white supple scar is usually formed, around vhich may be a brown pigmented area, but this last feature is often absent, xcept in the lower limb, and is there not peculiar to syphilis.

The rapidity with which destruction takes place in tertiary syphilitic ulcers is very marked, and serves to distinguish them from many other forms, and equally definite is their speedy healing under appropriate treatment, but if neglected they may persist for long and become indistinguishable (except perhaps by their site) from the ordinary chronic inflammatory ulcer.

The treatment consists in the administration of iodide of potassium (to which iodide of sodium and spirits of ammonia are useful adjuncts) or of mercury with the iodide, and in the local use of iodoform or black-wash. Rest of the part affected, tonics given internally, sea-air and the avoidance of stimulants may be all required in obstinate cases. In prescribing iodoform as a dressing it must be borne in mind that the drug, though a powerful agent in promoting healing, is liable to irritate the surrounding skin, setting up severe erythema or eczema. Using it as a weak ointment (5 to 10 grains to the ounce) or as a powder diluted with starch, &c., is often quite as effectual and less likely to irritate than employing the undiluted drug.

The serpiginous syphilitic ulcer is usually preceded or accompanied by the development of nodules or 'tubercles' in the skin, which are really of the same structure as the larger gummata. Their most frequent site is perhaps the margin of the hairy scalp and the alæ of the nose, upper lip, &c. Their tendency is to assume the crescentic or horse-shoe outline, and steadily to advance in one direction whilst healing in the part first affected. I have known such an ulcer start at the ankle, and (completely encircling the limb) travel up to the middle of the thigh before its further progress was stopped by treatment. It had never been more than an inch in width, and left the skin behind it quite supple. The question of diagnosis of this form from true lupus has already been alluded to. In its treatment the same applies as to gummatous ulcers, but it may be mentioned that oleate of mercury ointment (5, 10, or 15 per cent.) is often a very useful local application. In neglected or inveterate cases it is sometimes necessary to scrape the growth, or to cauterise it with the acid nitrate of mercury or actual cautery before healing can be obtained. If once thoroughly healed it shows no tendency to recur, unlike true lupus.

2. Tubercular Ulcers

Apart from the ulceration due to lupus we have to consider the strumous form resulting from tubercular abscesses of the cutaneous or subcutaneous tissues. Although most common in early life, they may originate in elderly subjects (senile struma) and are in the latter case of very unfavourable prognosis.

Glandular enlargement and abscesses are common complications, and pulmonary phthisis is of course not infrequent.

The appearance of a tubercular ulcer is very characteristic; dull purplish congestion of the edge, extensive undermining of the skin, thin oily discharge, and pale, flabby granulations at the base usually leave no doubt as to the diagnosis. When they heal a thick scar is generally formed, often with small cutaneous 'tags' along it.

The treatment consists in destroying the wall of the ulcer and sinus by scraping or cauterisation, and subsequently dressing the cavity with iodoform. Boracic fomentations, &c., cod-liver oil, residence at the seaside or in the country, good food, &c., are most important aids to recovery.

3. Chronic Inflammatory Ulcer of the Leg

The chronic inflammatory ulcer of the leg is seen especially amongst the poorer classes. The lower third of the leg towards the inner side is its usual site, and it often starts in some injury. The vitality of the tissues is previously lowered as a rule, however, by prolonged congestion from standing; both varicose veins and eczema are its frequent forerunners. The patient often states that the ulcer commenced as a small pustule, or that intense rritation at one spot led him to produce an abrasion by scratching. A weak heart or chronic bronchitis may favour the obstruction to the return of blood, the presence of the ulcer increases the congestion, and thus a vicious circle is set up.

The ulcer usually causes much pain and discomfort, though cases differ much in this respect; not only the edge becomes callous, but the floor also, and if it has existed long the immediately subjacent bone undergoes condensing ostitis, to which may be partly due the aching pain felt. Steadily ncreasing, the ulcer may encircle the limb and spread upwards over a large area, and at any time, from neglect of cleanliness, &c., it may take on sloughng action. The older the patient, as a rule, the less does the chance of healng become, though some very intractable ulcers are met with in young women n whom no constitutional cause can be assigned.

Treatment in very inveterate cases must be merely palliative, and a variety of applications (such as the Ung. Zinci, the Ung. Acidi Boracici, weak carbolic otions) may be tried in turn until one is found to suit the individual case. Amputation of the limb is occasionally necessary, but should rarely be urged, ince the low vitality of the tissues above often greatly impairs the result, and he risk to life in all elderly subjects is not inconsiderable.

A large number of these ulcers can, however, be cured, though unforunately there is great likelihood of the scars breaking down again. The following measures will be found useful :—

a. Rest and elevation of the limb are most important and should be carried out as far as possible.

b. Bandaging the leg from the foot to the knee, either with the ordinary inen bandage or with an elastic (Martin's) bandage. The latter cannot be used unless the ulcer is almost healed, and by its keeping in moisture someimes causes too great discomfort to be borne. An elastic stocking will often be of use in such cases. Carefully applied strapping above and below the ulcer is also beneficial.

c. To clean a foul ulcer and to promote granulation there are few dressings more valuable than boracic fomentations, made by wetting boracic lint and applying one or two thicknesses of it under gutta-percha tissue. The dressng must be changed once or twice daily, according to the amount of discharge.

d. The Ung. Resinæ, Ung. Iodoformi, Ung. Plumbi Subacetatis, and the wo previously mentioned, are of use according to the special indication, that s, whether stimulating or soothing applications are required.

e. Skin-grafting and sponge-grafting are valuable if the granulations have been got into a healthy condition and the patient can be kept in bed for a ew weeks. In using the skin-grafts they should be cut into minute pieces and only the epithelial layer employed.

f. In a large number of cases tonics do good, the bowels should be kept regularly open, alcoholic excess forbidden, and if varicose veins are present, it is often helpful to limit the amount of fluids taken, so far as is judicious.

There is one drug which has a very beneficial action upon inveterate ulceration, especially in old people, namely opium, the administration of which is said also to check the progress of phagedænic or sloughing action.

g. Blistering the edge of a callous ulcer was strongly recommended by Syme, and is occasionally useful. Some surgeons have advocated incising both base and floor of such ulcers, with a view to start a fresh granulating process.

4. Traumatic Ulcers

As already noted, a considerable proportion of the previous class of ulcers originate in some injury, often a very slight one, but we have to note some due to severe contusion of the skin of healthy individuals—really direct traumatic gangrene. This is especially likely to occur in regions where the skin lies immediately over a bone—for instance, the tibia or patella. An antiseptic poultice followed by some simple ointment is the best treatment, skin-grafting being advisable if the ulcer is large. The limb should be carefully kept at rest during treatment if the ulcer is situated over a joint.

In this class come the ulcers of artificial production, which may at first give rise to difficulty in diagnosis. A hysterical or idle girl, for the sake of exciting sympathy or notice, applies some strong chemical irritant to the skin, using great cleverness sometimes in concealing the cause of the ulcer which results, and in preventing it from healing. In one case I knew of a young lady who had applied sulphuric acid to the front of the left elbow, causing a deep ulcer, in which, for some time, the brachial artery lay exposed. The unusual situation of these factitious ulcers, their rapid formation and the character of the patient, will usually excite suspicion as to their true origin.

5. Malignant Ulcers

Rodent Ulcer, Epithelioma, Fungating Sarcomata, Scirrhous Ulcers.—These need not be described here, as they come under the head of tumours. It may be mentioned, however, that epithelioma may supervene in the course of any intractable ulcer which has lasted for some years, and that a particularly malignant form is liable to develop in old lupus patches, the patients being usually past middle life.

NON-MALIGNANT GROWTHS OF THE SKIN

Nævi

The essential feature of all angeiomata or nævi depends upon the presence of convoluted vessels closely packed together, commonly small veins and capillaries, but occasionally arteries. One form consists in a widespread area of small vessels, such as is seen on the face—the 'port-wine stain;' another (the true venous nævus) is situated more deeply and composed of much larger veins.

The terms cutaneous and subcutaneous are used with reference to nævi, though no sharp line of distinction can be drawn. They may be met with on any part of the body, the head and neck being their most frequent site, and it is common to find more than one on the same subject. If sections be made of an ordinary cutaneous nævus, it is curious to notice how slightly the lumen of the vessels shows in comparison with the thickness of the cellular wall. There is no doubt that after birth a nævus frequently increases in size; on the other hand, with advancing years they may shrivel in part or entirely disappear. Sometimes they ulcerate—a curious fact considering their high vascularity. 'Port-wine' nævi usually remain unchanged throughout life if untreated, and are by far the most resistant to treatment.

A *mole* is a congenital local hypertrophy of the skin, pigmented, and with usually abundant growth of hair on it. Moles are of little importance if seated on a part of the body naturally concealed by the dress, and even on the face are, if small, sometimes considered ornamental. But there is an undoubted tendency for them in advanced life to become the seat of melanotic sarcoma, and for this reason their excision should be advised. However, sometimes they are so large that removal by operation would leave an awkward wound, and here a plastic operation may be called for. They can also be destroyed by repeated cauterisation, but the process is not so satisfactory as excision.

One most curious growth allied to a mole is occasionally seen on the scalp—lobulated and softish projections of the skin with deep furrows between them, so arranged as strongly to suggest the brain-convolutions.

The treatment of nævi consists principally in one or other of the following measures:

1. The application at several parts of the nævus of the actual cautery (fine-point). This is most effective and leaves but little scar. It is well to proceed cautiously, and to do little at the first operation rather than too much.

2. If subcutaneous and venous, the cautery point may be thrust in several directions through the nævus, introducing it through only one opening in the skin.

3. Excision is suitable for small nævi, and is by some considered better than cauterisation.

4. Electrolysis has of late been extensively tried, two needles being used as the poles, and both pushed into the growth at a short distance from each other. They should be introduced at several points. The method may be successful in leaving imperceptible scars, but it is an uncertain one and needs to be repeated several times, as a rule, before much improvement occurs. It is especially adapted for nævi of the face.

Such measures as vaccination over the nævus, the application of ethylate of sodium, and subcutaneous ligature are occasionally useful, especially the latter—but this has the drawback of possible sloughing of the skin.

WARTS

The venereal form of wart is seen about the vulva, the prepuce, glans penis, and scrotum, in cases of gonorrhœa or vaginitis. They are especially prone to develop if there is phimosis and retention of the discharge, to the irritation of which they are due. They may attain a very large size and have very vascular bases. Sometimes a neglected condyloma becomes wart-like, but true acuminate or pointed warts have no real relation with syphilis. In treating them the gonorrhœa should be cured, circumcision performed if there is phimosis, a drying powder applied and strict cleanliness used. If they show no tendency to shrivel under this treatment they should be excised with scissors, and the bleeding checked if necessary with the actual cautery at a dull red heat.

Non-venereal warts are chiefly met with about the hands of young adults or children, and are composed of hypertrophied papillæ covered with epithelium. Each papilla contains a central vascular loop, and, especially if scratched and irritated, is liable to bleed. They may occur in great numbers on the hands (especially the dorsum) and forearms, and may undergo simultaneous and rapid atrophy. In their treatment it is important for the patient to abstain from 'picking' and irritating them; perhaps the best local application is the glacial acetic acid, which, applied repeatedly with a small brush or point of wood, will soon cause them to shrivel and drop off. Nitric acid is more painful in its action and less certain; nitrate of silver is useless as a rule.

In elderly subjects single warty growths are met with, the tongue, lips, and scalp being often affected. They are much more serious than those of early life, from their liability to go on to epithelioma. This is especially the case with warts of the tongue and lips, and on this account it is usually advisable to excise them.

Salicylic acid is a powerful agent in softening warty and hard epithelial growths of the skin, and is of much use in treating corns on the feet. It may be applied in the form of plaster which is renewed daily, or as a cream made with glycerine. As soon as the softening process is complete the part should be soaked in warm water, and the overgrown epithelium pared off with a knife. Of course, injurious pressure should be removed so far as is practicable.

Molluscum Contagiosum

This rather rare disease occurs in the form of small, round, projecting tumours, seldom much larger than a pea, especially on the face, neck, and upper part of the trunk. On section they are found to be lobulated and to have a structure somewhat resembling sebaceous glands, though they do not appear to originate in the latter. They are undoubtedly contagious to a slight extent, being for instance sometimes met with on the face of an infant and the breast of the suckling mother. The contagion appears to lie in the peculiar oval cells (yellowish, as seen under the microscope), which occur in their centres. Sometimes they come out in extensive crops over the body; after attaining a certain size they usually inflame and may drop off—the small ulcer left possibly giving rise to mistakes in diagnosis. The treatment consists in snipping off each molluscum body with scissors; if only the top is cut off the base should be pulled out with fine forceps.

DISEASES OF THE SKIN DUE TO ANIMAL PARASITES

Scabies

This disease is due to the Acarus Scabiei or Sarcoptes Hominis, the female of which burrows into the skin, selecting some part where the latter is thin, such as the clefts of the fingers and front of the wrists, and depositing her eggs in the burrow where they are hatched. The male insect pursues a wandering existence and does not burrow. The female may be extracted from its burrow by pricking the vesicle at the end of the latter with a stout needle, to the end of which it will probably adhere, and be recognised as a minute whitish speck just visible to the naked eye. Under the microscope its four pairs of legs and chitinous covering will be easily seen.

The irritation set up by the insect is very great, and is most intense at night-time, when the acari are active, leading to the production of pustules, eczematous patches, and fissures from scratching. In old cases the skin becomes much thickened, and burrows may be searched for in vain. Remembering its contagiousness, its favourite sites—the hands, feet, and adjoining parts—and the extreme itching of the disease, the diagnosis is usually easy. It should be noted that the face, scalp, and neck are hardly ever affected except in the case of infants, in whom also the accompanying eczema is liable to be very severe.

Treatment.—After a warm bath the patient should rub the Ung. Sulphuris (to which may be added some Balsam of Peru) at night-time, into all the affected parts. Three or four applications of this will probably suffice, though the eczema may require further treatment. Balsam of Peru and vaseline in equal parts are efficient for mild cases or for those occurring in infants. The itch insect does not inhabit the clothes, in this respect differing from the pediculus corporis.

PEDICULOSIS

Three varieties of pediculi are met with on the human subject—the pediculus capitis, vestimentorum, and pubis. Exceptionally also they are met with on the eyelashes.

The pediculus capitis, with its deposit of ova on the hair and the resulting eczema and enlarged cervical glands, must be only too familiar to those who attend hospital practice. The favourite part of the scalp to be affected is the occipital region. Sometimes the glandular swellings go on to form abscesses.

The pediculus vestimentorum causes severe irritation, which is always worse at nights, hence the production of fissures from scratching, wheals, and a general irritability of the skin with congested papules (prurigo). The parasite will be most readily found in the under-linen at the folds—though often the patient comes to the doctor with a clean set, when the diagnosis must be made from the symptoms and character of the eruption. The buttocks, lower part of the neck, thighs and trunk may all be affected. The pediculus pubis, or crab-louse, may be recognised clinging to the pubic hairs ; it also causes great irritation.

Treatment.—The white precipitate ointment, the Ung. Petrolei or one made of stavesacre (ʒij ad. ℥i) will speedily kill the adult parasites ; carbolic soap or lotion is also effective. The ova in the hair may be removed with the use of turpentine or spirits of wine, though it is often the best plan to cut off the hair. Frequent changes of linen, disinfection of the old clothes by hot air, and strict cleanliness should be enjoined in the case of pediculi vestimentorum. The eczema will be best treated by Ung. Metallorum, Ung. Hyd. Nit. Dil, or an ointment containing Balsam of Peru.

DISEASES OF THE SKIN DUE TO VEGETABLE PARASITES

The following are those met with in ordinary practice, with the name of the cryptogamic fungus on which they depend :

1. Favus—(Achorion Schönleinii).
2. Ringworm (Tinea Tonsurans, Tinea Barbæ, Tinea Circinata, &c.)—Trichophyton.
3. Tinea Versicolor—Microsporon Furfur.

In each of these three the fungus is found in two forms—as threads or mycelium, and as round or oval spores. The accompanying figure shows the close resemblance between the fungus met with in the different diseases.

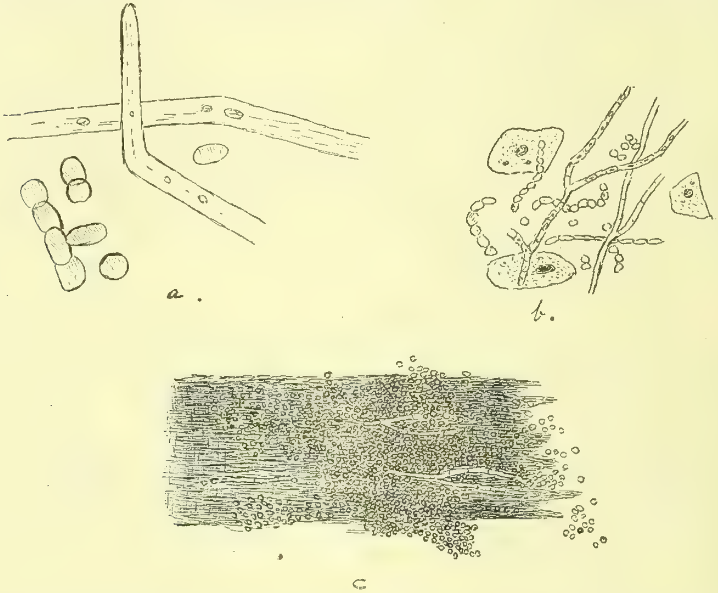


Fig. 25.—*a*, spores and mycelium from a case of tinea circinata (× 900). *b*, from a case of favus (× about 250 diam.). *c*, broken hair infested with spores of tinea tonsurans (× 300). It should be noted that these are seen under different magnifying powers.

There is no doubt that, though allied, they are distinct species, and that, for instance, the Achorion can only produce favus patches if inoculated on the body.

The seat of the parasite in all is the horny layer of the skin—*i.e.* the epidermis, the hairs, the nails, or the walls of the hair-follicles. These structures when invaded by the parasite tend to atrophy and to be cast off, there being often also around the parts affected considerable inflammatory exudation and thickening. This is best seen in tinea affecting the beard, or in kerion produced by ringworm of the scalp, and mistakes between the dry forms of eczema, and the cryptogamic diseases are not infrequent. The demonstration of the fungus is effected in the same way in all the forms of tinea ; the affected hairs and epithelium are washed with ether to remove the fatty matter and then soaked in liquor potassæ, a thin layer being then examined with the microscope, using a magnifying power of from three hundred to six hundred diameters. A good plan is to apply a drop or two of liquor potassæ to the skin, and then gently scrape off the sodden surface with a knife. Of the three, favus is by far the rarest in this country and the most difficult to cure; ringworm of head, &c., the most common and almost as refractory to treatment; while tinea versicolor is comparatively a trifling disease, being very easily cured.

FAVUS

Favus is only met with amongst the very poorest classes, especially perhaps the Jews; it also affects dogs, mice, cats, &c., and may be contracted from them. It nearly always commences in childhood, develops most freely on the scalp, but if neglected may spread even over the whole body. The growth of fungus is most luxuriant, and leads to a very characteristic feature —the formation of yellow circular crusts, like dried honey, cupped in their centre (at which a diseased hair usually projects). There is a peculiar musty odour about the part affected with favus—like the smell of mice, which is as characteristic as the cup-crusts. The hairs in an inveterate case may be wholly destroyed and bald superficial scars be produced. The disease causes but little irritation in itself, but is sometimes complicated by pediculosis or eczema. It lasts an indefinite number of years if untreated, and requires as a rule from three to eighteen months of thorough treatment to eradicate it; it is not, however, nearly so contagious as common ringworm.

The diagnosis is as a rule quite easy, pustular eczema being most often mistaken for it; but in this disease the mousey smell is absent, as well as the fungus, and the crusts rarely simulate the circular cupped ones of favus. In the latter disease they can be easily lifted off with a curette, &c., exposing a smooth pink depression in the skin.

Treatment.—Remove the crusts by vigorous washing, after soaking well with olive oil, then rub in daily one of the following parasiticides:

Resorcin	ʒi
Olive oil	ʒij
Lanoline	ʒvj

Chrysarobin	ʒss.
Olive oil	ʒij
Lanoline	ʒvj

Epilation with forceps is a painful but valuable measure in treatment, and in some cases blistering is valuable (but should only be employed over a small area at a time and not in very young children).

Coster's paint (Iodine ʒj dissolved in Ol. Picis liq. ℥j) may be painted on and left to dry, but the black colour produced is a drawback.

When after a month or two's perseverance with treatment the disease appears to be arrested, all applications should be left off and the patient observed from time to time. The appearance of the smallest favus crust should be the sign for recommencing treatment. Many cases, supposed to be cured, relapse after a few weeks.

RINGWORM OF THE SCALP

Ringworm of the scalp hardly ever occurs in adults, and is especially liable to attack children under ten; it is readily communicable and is no doubt often conveyed by the barber's instruments from one child to another. Calves and other young domestic animals are liable to it, and may transmit the fungus to man.

The fungus is usually found as spores, which often encase a hair completely, invading its substance and causing it to break off. The abortive stumps of hair, with scaly dry patches tending to have a circular outline, form the characteristic feature of ringworm. At first limited to a few scattered patches, later the disease may invade the whole hairy scalp. The affected hairs are much more easily extracted than are healthy ones, and, as Sir Dyce Duckworth first pointed out, they give a peculiar reaction with chloroform which constitutes a naked-eye test of their invasion by the trichophyton. If a few drops of chloroform be poured on to the suspected hairs placed on a cover-glass, and then allowed to evaporate, the diseased hairs become white. In every doubtful case, however, microscopical examination of the hairs soaked in liquor potassæ should be employed.

Itching is present to a moderate degree in most cases. If the disease lasts long bald patches may be left, but after a time the hair usually grows again well. That there may be a connection between ringworm and subsequent alopæcia areata is asserted by Mr. Hutchinson, but the two diseases are generally held to be quite independent. When ringworm affects the beard there is a greater tendency to the formation of pustules and small follicular abscesses than is the case in the scalp. There, however, we sometimes see a curious condition of boggy infiltration of the subjacent corium which simulates an abscess in that it appears to fluctuate. This condition is known as *kerion*, and consists simply of œdema and cellular exudation set up by the irritation of the parasite. There is no occasion to incise a patch of kerion, true pus being rarely formed, and it often leads to the death of the cryptogam over the affected area.

The fungus of ringworm may invade the skin in regions comparatively destitute of hair, and then leads to rounded, congested and scurfy patches with well-defined edges, or to rings which, by coalescing, produce a gyrate outline (tinea circinata). They are especially common on exposed parts, such as the neck, and may develop in adults who are free from ringworm of the scalp. The disease, since it is located only in the epithelium, and cannot become lodged in the hair-roots, is easily cured. The chief interest of tinea circinata to the surgeon lies in the not infrequent mistake which occurs as to its diagnosis, one form of syphilis closely resembling it. But if only the microscope be used in any doubtful case, the grave error of putting a patient with tinea circinata under prolonged and useless mercurial treatment will be avoided.

When the trichophyton obtains a hold of the region of the groin and axilla, its presence is accompanied by marked congestion and inflammation, and the term eczema marginatum is applied. There is usually a well-defined rounded outline. Eczema marginatum is a rare disease in cold climates, but common in very hot ones.

Treatment.—A child affected with ringworm should be isolated so far as is practicable; the hair on and around the affected area should be shaved off once a fortnight; and a linen cap should be worn continually, and changed frequently. After thoroughly washing the part, one of the following applications should be made:

Ointments.—(1) Oleate of copper (one drachm to the ounce); (2) Oleate of mercury (5 to 20 per cent.); (3) Salicylic acid (1 drachm to the ounce);

(4) Chrysophanic acid (5 to 15 grains to the ounce). Lanoline with olive oil or vaseline are used as the bases, and the ointment should be thoroughly rubbed in night and morning. There is always some risk (especially with chrysophanic acid) of causing too much irritation, and the strength of the application will need to be varied according to the age of the child, &c. For inveterate cases, acetic acid, Coster's paint, and blisters are useful applications, but should only be employed over a small area at a time.

Sulphurous acid (a saturated solution in water) is perhaps the best application for tinea circinata and eczema marginatum.

TINEA VERSICOLOR (CHLOASMA)

occurs on the trunk, especially on the front of the chest, as brownish patches in adults who are neglectful of personal cleanliness, and who wear the same flannel underclothing for considerable periods. It has been noticed to be frequent on phthisical patients, and those who perspire freely. The fungus is readily found in scrapings of epithelium from the affected area.

The treatment is simple and speedily successful—frequent washing and change of linen, with the use of sulphurous acid lotions or an alcoholic solution of salicylic acid (10 per cent.).

DISEASES OF THE NAILS.

Like the hairs, the nails are liable to be invaded by the fungus of tinea tonsurans and of favus, both mycelium and spores being occasionally found in their substance. In association with eczema of the hands or feet the nails may become affected, the inflammation then chiefly involving their roots and causing secondary changes in the nutrition of the nails themselves. With severe general psoriasis, too, there is sometimes great thickening of the nail-substance, which becomes brittle and opaque, but in the slighter cases the nails usually escape. A form of dry chronic onychitis is also met with, in which no general skin disease exists—a very troublesome disease to treat; arsenic given internally being the most likely measure to do good, combined with frequent soaking the affected finger-ends in a tar-lotion.

Syphilitic onychitis usually occurs during the secondary stage; the nail-ends become brittle and irregular, this form occurring both in the acquired and inherited disease. Sometimes the nail-root is especially involved, becoming narrowed as though it were pinched laterally (see 'Illustrations of Clin. Surgery,' vol. 2, plate 81). Shedding of the affected nails may then occur, new healthy nails ultimately taking their place.

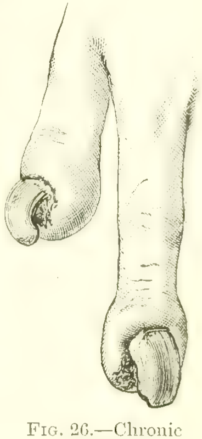


FIG. 26.—Chronic Onychia.

A peculiar and troublesome form of ulceration, creeping round the nail, and occasionally resulting in its complete detachment, is met with especially in those who have to do with *post-mortem* work, surgical dressings, &c. It is, as a rule, decidedly painful, and although it is not necessary in most cases to remove the nail for its cure, yet the finger should, if possible, be kept protected by an antiseptic dressing under oiled silk. Powdered boracic acid or a powder containing equal parts of iodoform, tannic acid, and oxide of zinc will be found of service as a local application.

The exfoliation of a nail as the result of a crush is too well-known to need description, but it may be noted that frequently the process is very gradual and painless, and in such cases there is no need to hasten it by premature avulsion. A new nail is probably more likely to grow if the exfoliation is left wholly to nature.

A slight injury is sometimes the primary cause of what is known as *onychia maligna*, an affection practically confined to children. The nail becomes loosened, altered in shape and much discoloured, the finger-end swells up and discharges a fœtid pus from below and around the nail. So severe may the inflammation be in onychia maligna, if neglected, that the terminal phalanx is liable to necrose, and there is little or no tendency to spontaneous cure. This may be due to the fact that its subjects are generally delicate or 'strumous' children. With proper treatment recovery is usually very rapid. The diseased nail should be removed with forceps, and a dressing of iodoform or of the liquor arsenicalis (one drachm to the ounce) applied. If these measures fail a single application of the acid nitrate of mercury or nitric acid will usually suffice to stop the ulceration. Tonics, especially iron, are generally useful adjuncts to the local treatment.

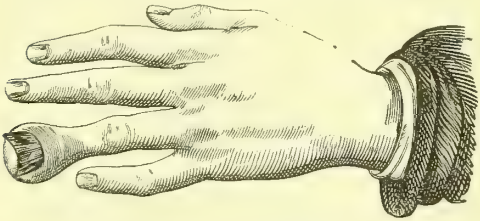


Fig. 27.—Onychia Maligna.

Ingrowing toe-nail is nearly always met with at the outer side of the great toe, and may be produced by the pressure of tight boots, or by cutting the nail too deeply away at its angles. Unhealthy granulations form around and bury the edge of the nail, and much discomfort is thereby produced. The treatment in the early stage consists in the removal of pressure from the toe and applying a few shreds of cotton-wool charged with the astringent powder already mentioned under the edge of the nail with a probe. Cleanliness and the daily repetition of this process will sometimes suffice. If it does not succeed the central portion should be scraped thin with a piece of glass and some thin lead-foil inserted under the angle. The nail itself should never be removed if it can possibly be avoided; when it grows again it is even more distorted than it was before. The granulations, if very exuberant, may be cut away, and iodoform dressing applied; but removal of the whole of the side of the fleshy part of the toe, though strongly recommended by some, is unnecessarily severe.

CHAPTER II

INJURIES AND DISEASES OF BLOOD-VESSELS

Section I.—Injuries

Blood-vessels may be contused or bruised; ruptured, either partially or completely; wounded, or divided. When the external coat remains intact, as in ligature of arteries, and in some cases of contusion, and when, owing to the way in which a vessel is torn across, the coats are all twisted up together, no blood is lost. In every other case the immediate and most prominent symptom is hæmorrhage, either externally or into the substance of the tissues.

Hæmorrhage may be capillary (coming not so much from the capillaries themselves as from vessels too small to secure individually), venous or arterial.

Local Symptoms

Capillary hæmorrhage is never serious except in patients with the hæmorrhagic diathesis. It is sometimes tolerably abundant from the walls of an abscess, the sudden relief of pressure causing the delicate capillaries in the granulation-tissue to give way; and after the application of Esmarch's bandage, when a limb has been kept anæmic throughout the course of a prolonged operation, it may be so considerable as to make the operator doubt whether there has been any real advantage to the patient; but as a rule it stops at once on exposure to the air, especially if the part is raised at the same time, or with gentle compression. Ice-cold water may be poured over the exposed surface if this fails; or better still, water at the temperature of 130° F., about as hot as can be borne with the hand. Carbolic lotion should not be used, as this tends to make the clot disintegrate again. In many cases, especially after amputations in which the bloodless method has been adopted, it is better to close the wound and trust to firm bandaging and elevation than to keep the patient waiting on the operating-table; but due provision must be made for drainage, or there may be a very considerable degree of traumatic fever.

Venous hæmorrhage is recognised by the dark colour of the blood and the steady character of its flow. Unless there is considerable pressure upon the cardiac side (as when a ligature is tied round the limb, and occasionally in hæmorrhoids) the stream is always continuous, never in jets. Usually it comes from the lower or distal end, but when a large trunk is wounded, or a varicose vein, in which the valves are incompetent, gives way, he rush from the cardiac side may be so great as to prove fatal within a very ew minutes. The slightest pressure, applied to the right spot, or merely aising the part so that it is not dependent, is sufficient to stop the flow at once; but many instances are recorded in which, for want of this simple precaution, his accident has proved fatal.

Arterial hæmorrhage may be *primary*, at the time of the injury; *recurrent*, within twenty-four hours; or *secondary*, from any time after this until the wound in the vessel is healed. The distinction between the two last is of considerable importance. Recurrent hæmorrhage is due to failure in the temporary closure of an artery; the ligature by which it is secured has slipped, or pressure has failed, or as the heart recovers from the shock and beats more vigorously the clot has been washed out, and the contracted condition of the vessel's wall unfolded again by the internal pressure. Secondary hæmorrhage, on the other hand, points to failure in the measures by which permanent closure is effected. The wall of the artery is too badly nourished, from atheroma or from suppuration round it, for the exudation to become organised; or the ligature has been tied so tightly that it cuts through before the protecting barrier of lymph is sufficiently strong to resist; or the presence of a sequestrum or of some other foreign substance has caused ulceration without repair. The symptoms too are different, the former is rarely sudden and is seldom serious unless the wound is loosely covered over with a thick layer of absorbent material; then sometimes it escapes notice until a very large amount has been lost and the patient's face is blanched. The latter, though it rarely occurs without giving a warning (some slight stain on the dressings the day before), may be of the most serious description, especially as it nearly always comes from the largest vessels, in which the pressure is very high.

In primary hæmorrhage from a wounded artery the blood is bright red, and comes in distinct jets, which, even in vessels smaller than the radial at the wrist, may shoot three or four feet. Occasionally, however, when the patient is anæsthetised with nitrous oxide, or is partially asphyxiated from excess of carbonic acid, the colour is darker, approaching that of venous blood; and when the wounded vessel is concealed at the bottom of some deep cavity, the flow may apparently be continuous. Recurrent hæmorrhage, when the opening is exposed, does not differ in any material way; but sometimes in secondary bleeding after ligature of an artery in its continuity the blood wells up slowly in a continuous stream, coming from the distal end only, and having lost its force in the collateral vessels.

When the blood, instead of escaping externally on the surface of a wound, pours into the tissues or one of the natural cavities of the body, the local symptoms are regulated by the size of the vessel, the pressure of the stream, and the readiness with which surrounding structures yield. Hæmorrhage from small vessels is rarely important unless the number that give way is very great, as in some of the dorsal or lumbar hæmatomata. There is local swelling, which usually disappears again after a time, although it occasionally ends in organisation or suppuration. If, however, the vessel is an artery of any size, and the tension is not checked, the tissues may become inflamed, or suppuration may set in or the part may even become gangrenous from the collateral circulation being cut off.

Hæmorrhage into the pleural or peritoneal spaces, internal hæmorrhage in the strict sense of the term, often causes no local symptoms. In other cases a certain degree of dulness can be made out in the dependent parts, and an alteration in the level of the fluid in different positions of the body, especially as blood when extravasated into serous sacs coagulates slowly: but although this, when it does occur, is distinctive, its absence proves nothing.

CONSTITUTIONAL SYMPTOMS

The rapidity with which the blood is lost is almost as important as the quantity. When it pours out under high pressure from some great artery, the face becomes pale and livid at once; the lips are white, the extremities cold, the pulse low and quivering, and the respiration hurried and shallow, interrupted every now and then by yawns or deep sighs. The voice is lost, there are noises in the ears, the eyesight fails, sickness comes on, and the arms are tossed vaguely and wildly about over the head. If, on the other hand, the loss is more gradual, the face and lips become peculiarly transparent, like wax, the pulse is small and fluttering, the breathing quick and very irregular in depth, giddiness and faintness come on with the least exertion, and if the loss continues, dropsy makes its appearance, owing to the impoverished condition of the blood. In such a state the slightest further drain may prove rapidly fatal. Sudden hæmorrhage produces a much more marked effect than oozing to the same amount continued over several hours; and the consequences at the extremes of life are much more serious than in adult age. Even when the immediate effect is not fatal, recovery is often incomplete, the patient never really regaining strength, but dying, perhaps some months later, from some intercurrent trouble.

NATURAL ARREST OF HÆMORRHAGE

The natural means by which hæmorrhage is stayed are partly constitutional, partly local.

1. **Constitutional.**—The force of the heart-beat diminishes in proportion to the amount of blood that is lost; in syncope it can scarcely be felt. Meanwhile, before the strength returns, the blood has time to coagulate, and with good fortune this may prevent further loss. In the case of large arteries, however, it is seldom effectual; as the fainting passes off, the heart regains its power, and the bleeding begins again. Sometimes temporary cessation and recurrence alternate more than once before death ensues. It is said that the blood which is lost towards the end coagulates more readily than that which comes at the beginning, and this may help a little.

2. **Local.**—Owing to the structure of the internal and middle coats of an artery, the inner tube contracts as soon as it is divided and shrinks to such an extent that only a small orifice is left. This is due, in part at least, to its muscular fibres. At the same time, owing to its great elasticity, the two ends retract and become separated from each other by a considerable distance, the inner part again shrinking very much more than the outer. If the vessel is put on the stretch first, so as to bring this elasticity into full play, as when for instance a limb is torn off, the orifice may contract and retract to such an extent that no blood at all is lost. As a rule, however, a certain amount pours out, and this flowing over the torn and irregular surface formed by the broken ends of the internal and middle coats and the nterior of the sheath, coagulates and fills all the space round and inside he ruptured end with what is known as the external clot.

Generally, but by no means invariably, an internal clot forms as well. The blood as it whirls round in the closed end forms a conical-shaped coagulum, the base of which rests upon the ruptured coats, to which it is firmly adherent, while the apex, lying loose in the interior, reaches as high as the next largest branch. This, when it is present, must act to some extent as a buffer, saving the outer clot from the shock, but it is not essential to permanent repair.

If, when the heart recovers, this combined barrier is sufficiently strong to resist the impact of the blood, the permanent changes begin. The vasa vasorum, the minute vessels in the sheath, and those which lie in the tissues round, dilate ; more plasma pours through their walls ; the leucocytes pour out more rapidly and in larger numbers ; the torn ends of the fibres swell up and disappear ; and gradually the external clot and the base of the internal one are invaded from all sides by the cellular exudation, and the fibrin and red blood-corpuscles are gradually replaced. The endothelium of the vessel itself near the torn end disappears as such, and fuses with the growing lymph ; probably, except in the largest trunks, under the stimulus of injury it regains some of its lost power and begins active growth again. Possibly some of the leucocytes in the still circulating blood, where it whirls round and round the conical clot, help as well, gradually filling up the narrow cleft that lies between it and the wall. In any case, by the third day a button of firm newly-formed lymph seals the end of the vessel, lying between the edges of the curled-in coats to which it is firmly adherent. After a time this lymph becomes vascular ; new vessels form, some coming from the vasa vasorum in the thickened and softened coats, others springing from the cavity of the vessel above, many from the sheath as well ; and organisation rapidly follows. The final change is the shrinking of the newly-formed tissue, the gradual obliteration of many of its vessels, and the contraction of the artery above the seat of division up to the origin of its next large branch.

When an artery is divided in its continuity the changes are the same ; but repair is much less perfect at the distal than the proximal end, and secondary hæmorrhage is much more common from the former than from the latter. In some cases, the two ends separate completely and retain no connection with each other ; more frequently a fibrous band is left between them ; and occasionally a vessel is developed, and enlarges by slow degrees until it re-establishes a direct communication.

Whether hæmorrhage ceases spontaneously or not depends partly upon the size of the vessel, partly upon the character and direction of the wound. If the artery is torn in two, even the axillary at the shoulder may close completely without the loss of a drop of blood. In a case of clean division, as with a knife, the result is more doubtful ; an artery the size of the tempora (provided it is perfectly healthy) usually causes no trouble ; the brachial o the posterior tibial in the upper part of its course retracts sufficiently for time ; but hæmorrhage is almost certain to commence again as soon as th heart regains its power. In the femoral this almost always happens. A transverse wound which does not completely sever the vessel never stops bleeding of itself unless it is of the most minute dimensions ; the elasticity of th coats holds the wound open, and many of the worst cases of hæmorrhag are traceable to the incomplete division of some comparatively sma branch.

Arteries that are either rigid from atheroma, or are contained in rig met with after old suppurating wounds (such as septic compound fractures) naturally, if they are divided, cannot retract, and consequently bleed furiously.

Treatment of Hæmorrhage

The first thing always is to secure the bleeding point wherever it ma be, and whether it is an artery or a vein. The subsequent treatment turn entirely upon whether this can be done or not.

1. *If the bleeding point has been secured*

When the loss of blood is sudden, every care must be taken to keep the heart and brain as well supplied as possible. Any quick movement, particularly raising the head, might at any moment bring on fatal syncope. The patient should be laid perfectly flat, without a pillow, and with all the clothing loosened round the chest; it may not be possible to remove it. The limbs should be raised, and they may be even lightly bandaged. Hot bottles and warmed blankets should be packed all round, and every attempt made to maintain the temperature. If the heart is failing, hypodermic injections of brandy or ether may be tried ; in other cases, very small quantities of hot brandy and water, not more than half a teaspoonful at a time, may be given at frequent intervals by the mouth. Rectal injections of warm water are sometimes of great service, absorption taking place with very great rapidity owing to the diminution of fluid in the vessels. Finally, if none of these measures suffice to maintain the action of the heart, intravenous transfusion with human blood or with saline solution may be tried. The blood of other animals, in spite of the fact that it is said to have succeeded, must never be used ; the plasma of the one destroys the blood-corpuscles of the other, and, even if it does not cause general clotting, makes the destruction worse ; and milk does not appear to possess any advantage. Intra-peritoneal transfusion has succeeded in animals, but I am not aware of its having been tried in men.

Where the loss of blood is gradual the same method may be adopted ; but instead of relying upon the temporary effect of stimulants careful dieting is required with easily digested food, and after a time very mild preparations of iron in small doses. If the loss has been severe, cases of this kind require watching for many weeks.

2. *If the bleeding point cannot be secured*

In internal hæmorrhage this is of course often impossible ; and even when it is external it is a rule, in primary bleeding, not to interfere further, if the loss has ceased when the wound is exposed. The injured part may be covered with iodoform under gentle pressure, and must be watched night and day ; but it should not be explored.

In cases of this kind great care is required to prevent collapse on the one hand, and avoid reaction on the other. The wound in the vessel is closed chiefly by coagulum, and the main hope lies in this not being washed away when the heart regains its power. Accordingly, stimulants should never be given unless the case is desperate. Absolute rest, warmth, and small fragments of ice from time to time, to relieve thirst, are all that is possible at first. Later, if other conditions admit of it, small doses of opium (combined with gallic and sulphuric acids) are very beneficial; but the diet must be kept low; the patient must not be allowed to raise a finger; and even talking must be prohibited until there is a reasonable chance of the wound in the vessel having become sealed. The actual onset of secondary hæmorrhage can nearly always be traced to coughing, laughing, straining at stool, or some other trivial exertion.

INJURIES OF ARTERIES

Rupture

Rupture of an artery may be complete or incomplete, and may occur with or without an external wound. It is said to be complete when all the coats are divided at any one spot, not necessarily in their whole circumference.

1. *Incomplete rupture*

The coats of an artery may be torn by a contusion, if the vessel is superficial or is caught against the bone (the common femoral, for instance); or they may give way from over-extension, especially at the knee-joint, and in the reduction of old dislocations. In the operation of ligature, partial rupture is often produced deliberately with the view of effecting more certain closure.

Owing to their anatomical structure the internal and middle coats usually give way without the external (fig. 28). If tied tightly with a narrow ligature they are cut as cleanly as if divided with a knife, and then they retract some little distance, but do not curl in far. On the other hand, in contusions, and when an artery is torn from over-extension, they not unfrequently twist up together, and completely close the lumen. In disease, when an artery is rigid and calcareous, or is softened and thinned, partial rupture is not uncommon; but the behaviour of the coats of the vessel is entirely different, and usually the rupture sooner or later becomes complete.

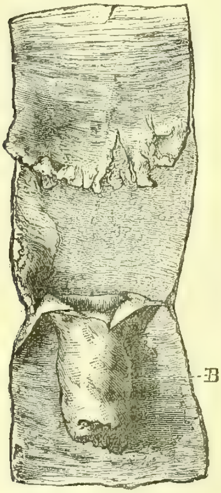


FIG. 28.—Laceration of the internal coats of an artery from injury, with a coagulum (*B*).

Partial rupture of an artery may end in its occlusion; in imperfect repair with the formation of a traumatic aneurysm; or in complete rupture.

In the first of these three the clot, as already described, forms on and beyond the torn ends of the internal and middle coats; and gradually becomes replaced by vascular organising lymph; the artery is obliterated, although occasionally a small vessel forms subsequently in the band that joins the ends; and the consequences depend upon the collateral circulation. If this is good, no ill result ensues; if the walls of the vessels generally are rigid, and the heart's action weak, or if, owing to extravasation, dilatation of the neighbouring branches is impossible, gangrene follows.

In the second, organisation and repair begin, but the process is not completed; and under the influence of the blood-pressure the still unbroken external coat, the blood-clot that lines it, and the tissues outside it stretch more and more until they form the wall of a sac, in other words, a *traumatic aneurysm*. This is distinguished from the ordinary form (which likewise can usually be traced back to some violent strain) by the fact that the wall of the artery for the rest of its course is perfectly healthy.

In the third case the remaining part of the wall gives way, either at once or later, after partial repair and the formation of an aneurysmal sac; the rupture becomes complete.

2. *Complete rupture*

When there is an external wound the hæmorrhage is usually profuse, and if the vessel is of any size continues until either syncope sets in or the result proves fatal. Sometimes, however, when the artery has been violently pulled out, as when a limb is torn off, the internal and middle coats curl up so tightly that the blood does not escape.

When there is no external wound the blood spreads far and wide in the limb, wherever the resistance is least, forming what is known as an *arterial hæmatoma.* It is most common in connection with fractures, and the reduction of old dislocations of the humerus. If the rent is a large one, and the tissues round the vessel are loose and yielding, as in the case of the axillary and popliteal, the loss of blood may be so profuse as to cause syncope; an immense, ill-defined swelling forms within a few moments; the pain is extreme; the limb beyond becomes swollen, œdematous, and cold; and the pulse in the distal vessels ceases completely. Pulsation can rarely be detected, except perhaps over a limited area; and, as a rule, there is no bruit, or if there is, it is not conducted along the vessel, as in the case of an aneurysm. When, on the other hand, the opening is a small one, or the tissues immediately around it resist and restrain the outflow, the symptoms are much more vague, and resemble at first those of traumatic aneurysm; then, perhaps quite suddenly and after several days, the barrier gives way, and the full effect is produced at once.

The diagnosis of an arterial hæmatoma from an acute and deep abscess is sometimes very difficult, as there may be a considerable degree of inflammation round it. If a thrill, or bruit, or pulsation can be detected, it is clear at once; but in any case of doubt a puncture with a grooved needle is perfectly safe. Occasionally it is mistaken for a rapidly-growing malignant tumour.

Treatment.—Simple *occlusion* of a large vessel as a direct result of injury is very rare; the small ones may be more commonly affected, but then the symptoms are too vague to be recognised. If it is noticed that the limb is cold and has lost sensibility and power, and that the pulse cannot be felt in the parts below without there being any swelling or extravasation to account for it, the diagnosis is very probable. The limb should be raised, wrapped thoroughly in cotton-wool without being bandaged, and carefully watched. If gangrene sets in, it will probably be of the dry variety, and if the access of moisture can be prevented a line of demarcation will gradually form without any constitutional disturbance. One or two toes only may be lost even when the popliteal is blocked.

Traumatic aneurysm usually makes its appearance some time after the accident, as a soft pulsating swelling in the course of one of the arteries. It can readily be emptied by pressure upon the trunk above, and fills itself again in the characteristic manner. As the vessel from which it springs is perfectly healthy, it may be dealt with in almost any manner that is suited to the locality and size of the artery. When, for example, it occurs in the anterior tibial in connection with fracture of the leg (the most common form) it usually gets well of itself while the fracture is becoming firm.

An arterial hæmatoma is much more serious, whether it occurs at once or is secondary to the formation of an aneurysm. If the extravasation has ceased to extend and the circulation in the limb below is good, gentle pressure may be tried, partly to support the vessel, partly to assist absorption. If, on the other hand, the swelling continues to increase there is no alternative, an attempt must be made to find the seat of injury and tie the artery above and below. The vessel must be compressed on the cardiac side ; a free incision made into the extravasation, all the clots turned out, and the seat of injury exposed. Then a ligature must be placed round it above and below at a sufficient distance to ensure the wall being healthy, and if it is thought advisable the trunk may be completely divided in between. A director or a stout probe passed through the opening into the vessel renders its isolation from the blood-stained and thickened tissues round much more easy. In this way I secured the external iliac and the common femoral for a rupture of the intermediate portion of the artery, which only became complete four weeks after the receipt of the injury that caused it. The presence of gangrene leaves no choice ; amputation, if practicable, must be performed without delay.

Wounds of Arteries

The effects of complete transverse division of an artery in a wound have been already described. The internal and middle coats contract and retract; if the vessel is a very large one death ensues, in spite of this, at once. If not so large, syncope occurs ; the heart beats more feebly, and an external, and then an internal, coagulum forms. Sometimes this is not enough ; when the heart regains its power, bleeding recommences, and soon proves fatal; in most instances fortunately, and probably in all when the artery is as small as the temporal and the walls are healthy, the combined resistance is sufficient ; lymph is poured out, and organisation and permanent repair set in.

Incomplete division on the other hand, unless the wound is a minute puncture, does not admit of repair unaided. A transverse cut is held widely open by the elasticity of the wall; and a longitudinal one gapes with every pulse-beat. Probably most of the cases of persistently recurring hæmorrhage from small and medium-sized vessels are really due to the fact that the wall is only partially cut through; complete division, allowing the coats to retract all round, is, in many cases, an effectual cure.

Arterial hæmorrhage can only be mistaken when the blood wells up from the bottom of some deep cavity; or when, some days after the complete division of an artery, repair fails at the distal end. When this occurs, the flow is continuous rather than intermittent ; but its steady persistence and rapidity rarely leave the question in doubt for long.

Treatment.—The treatment of a wounded artery depends upon the size and position of the vessel, and upon whether the bleeding has already ceased or is still going on. In the former case steps must be taken to prevent recurrence ; in the latter, as the natural method of arrest is insufficient, provision must be made to assist and supplement it.

Temporary measures.—Hæmorrhage must be stopped at once by pressure upon the bleeding point, or upon the artery above. If the spot is the right one, the amount of force that is required is exceedingly small. The subclavian can be controlled with the thumb pressing it down upon the first rib, the operator standing behind and somewhat over the patient; the brachial is even easier, especially in the middle of the arm where it lies in the angle on the inner side of the biceps. In the lower limb very little is required for the femoral as it passes from beneath Poupart's ligament, and digital compression can easily be maintained for half an hour and more, if the operator stands well above the patient so that his arms are almost straight. In Hunter's canal a firm grasp can control it against the femur from the inner side, but it cannot be kept up for long. The tibials are only superficial for a short distance above the ankle; in the upper part of the leg they are out of reach.

Firm flexion at the knee or elbow diminishes the force of the stream below very considerably, and may, if carried far enough, stop it altogether; but it is very painful.

In thin people, and in children, the abdominal aorta can be felt beating just above and a little to the left of the umbilicus, and here it can be compressed with ease. If, however, there is much fat, or the abdomen is prominent, it is much more difficult, and sometimes it can hardly be managed even with Lister's tourniquet.

Tourniquets are required when compression has to be maintained for any length of time; the simplest is *Esmarch's*, a piece of $\frac{3}{4}$-inch rubber tubing twelve or eighteen inches long, with a hook at each end. No anatomical knowledge is required. It is simply stretched out and wound round the limb above the bleeding point, or in the case of the hip and shoulder arranged in a figure of eight with one loop in the axilla or groin, as the case may be, and the other held to prevent slipping. A small wooden block to fit over the artery is very useful for the femoral at Poupart's ligament; it must be grooved on the upper surface to receive the band, and padded on the lower, so that the whole pressure may fall upon the right spot.

There are, however, several disadvantages in connection with this. Nerves have been paralysed by it, the prolonged compression and anæmia leading to physiological interruption. It encourages sloughing, especially if applied to check primary hæmorrhage before amputation. The amount of oozing that follows when it is removed is so great that, although it absolutely prevents loss of blood from large vessels (and so is of undoubted service when nothing better is at hand), it is sometimes questionable whether in the case of a large wound the real saving has been very considerable; and it is intensely painful. Accidents of this kind are much more likely to happen

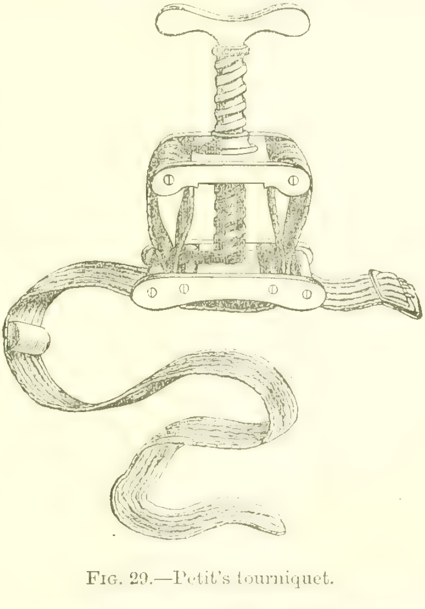


FIG. 29.—Petit's tourniquet.

when the limb has been previously rendered bloodless by the use of Esmarch's bandage ; but they have been known to follow the application of a single rubber band.

Other kinds of tourniquets are only of use for special arteries. *Petit's* (fig. 29) can be employed for most below the axilla and the groin. The pad, or preferably a roller about an inch and a half thick, is placed over the main vessel, the band is buckled close to the limb and the screw turned quickly, so as to compress the artery as soon as the veins and avoid passive congestion. A bandage round the limb is advantageous, as it prevents the skin being dragged.

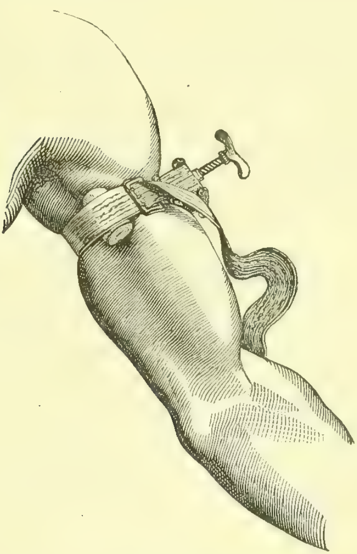


Fig. 30.—Petit's tourniquet applied to the brachial.

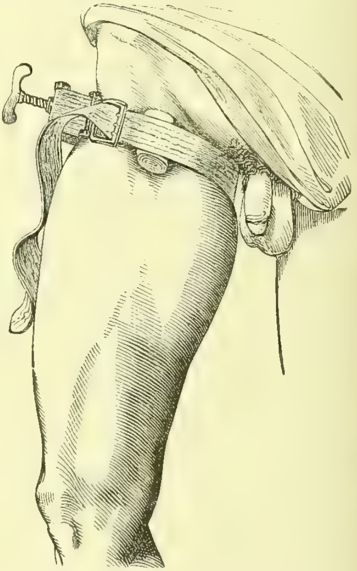


Fig. 31.—The same applied to the femoral.

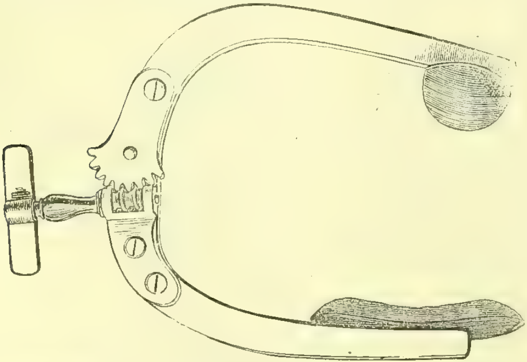


Fig. 32.—Signoroni's tourniquet.

Signoroni's (fig. 32) is horse-shoe shaped with a pad at each end (one for pressure upon the artery, the other to give sufficient resistance) and a screw and ratchet in the middle, so that the arc can be opened or closed at will. It is chiefly of use for the femoral in the groin, the larger pad being placed well beneath the tuberosity of the ischium. *Lister's* is made in the same way, but is of larger size and intended for the abdominal aorta. It should be placed upon the patient's right side, so that the vessel does not slip off the fourth lumbar vertebra, and should only be screwed up at the last moment, and with just enough force to interrupt the circulation.

Davy's rectal lever is a smooth round bar of wood which is introduced through the anus into the end of the sigmoid flexure, so as to cross the common iliac in the angle between the lumbar spine and the psoas. By raising the handle the vessel is readily compressed. It may be used for the right side as well as for the left, and to control the branches of the internal as well as those of the external iliac; but great care has to be taken in introducing it, owing to the folds that are always present in the rectum. Perforation has been produced by it.

In cases of emergency a tourniquet can be improvised at once out of a handkerchief tied round the limb and twisted tightly. A stone should be placed inside it to make a firm pad over the vessel.

In wounds of the neck and in some parts of the trunk pressure with the finger on the bleeding point is the only temporary expedient of any good.

Wherever it is possible and the bleeding is not too serious, the patient should be removed at once to a convenient couch or bed. This must be done with the greatest care, the patient not being allowed to raise himself or make the least effort. Then, as soon as a good light has been obtained, the clothing must be gently separated or cut over the seat of injury, all blood-stained bandages and wraps removed, and the wound thoroughly inspected.

If the bleeding has ceased and does not return when the tourniquet is removed, the parts around may be quietly sponged and the wound itself dusted with iodoform, but the clot must on no account be detached. Careful watch must be kept for recurrent hæmorrhage; a tourniquet may be placed on the limb ready to be screwed up at any instant. It is quite possible that when the heart regains its power, a slight serous oozing will begin, and that very soon the coagulum will be washed away and the bleeding recommence; but until this happens any interference is unjustifiable. The best hope lies in absolute rest; if the clot is not disturbed organisation may set in and gradually render the wound secure.

Permanent measures.—If the bleeding persists, it must be stopped either by making use of some general remedy, such as heat, cold, or pressure; or by isolating and securing the vessel. Which of these plans is to be adopted depends upon the size and position of the bleeding point.

Cold.—Simple exposure to the air is sufficient to stop oozing from small vessels; if a greater effect is desired, ice-cold water or ice itself may be used. It acts upon the muscular coat and consequently is of especial use when many small arteries have been divided.

Heat.—Hot water (temp. 125° F. to 140° F., practically as hot as can be borne with the hand) acts better than cold on tissues that have been exposed to the air for some time (as in prolonged operations) or rendered bloodless by Esmarch's bandage. The *actual cautery* is used where the structures are soft and spongy and the oozing persists without its being possible to define any one spot. It should be black or at the most dull red; if it is brighter the tissues are burnt away and stick to the iron, so that when it is removed the bleeding begins again. When applied to an artery an eschar is formed, generally of all the coats, which curl up together, and an internal coagulum is deposited almost at once upon the injured tissues. The process is not instantaneous; if the vessel is of any size the point of the cautery must be held in steady contact with it for some moments, or the closure is incomplete. Secondary hæmorrhage is more common after this than after torsion or ligature.

Pressure is of much wider application. General oozing that does not yield at once to cold or heat may be effectually checked by bringing the surfaces firmly together. It is by far the most convenient method for arteries of the scalp; the occipital or temporal may be secured at once with a bandage; indeed, care is required in applying a capelline one not to interrupt the circulation unnecessarily. In punctured wounds involving the deep palmar arch there is practically no alternative, and nearly always, even when arteries are secured in other ways, pressure is employed to assist, partly for the sake of the support it gives, partly because of the control it exercises over the circulation.

If the bleeding point is on one of the limbs and the hæmorrhage is definitely arterial, the pressure must be applied systematically, and with a clear idea as to what is required. A well-padded, accurately-fitting splint is essential to offer a certain degree of resistance, and to keep the part at rest. The whole of the limb beyond, and for some distance upon the cardiac side, must be carefully packed with cotton-wool and bandaged. A graduated compress made of many layers of lint, placed one upon the other and cut so as to form a cone, must be adjusted upon the exact spot; the apex piece may advantageously be made of cork; and then one or two small strips of strapping must be carried over the base to fix it securely in its proper place. Further, a small longitudinal roll of lint may be adjusted over the course of the main artery above the wound, and secured in the same way. Then, finally, separate bandages are to be placed over each of the compresses, so that the pressure upon one can be varied or removed without affecting the other. The limb should be raised after the bandages are in position, and the joint above flexed, so as still further to check the flow; but very careful watching is required for fear of gangrene. If no trouble of this kind threatens, and if the hæmorrhage does not return, the dressing of the wound should be left undisturbed as long as possible; and when it is detached the lowest piece of the compress should be left untouched. When the tissues have healed beneath, and the wound in the vessel is sound, it will come away of itself; and if the part is well dusted with iodoform, and kept dry, there is no fear of any extensive suppuration occurring.

The plan may be adopted for punctured wounds of the deep palmar or plantar arch. The amount of pressure is not so important as the exactness of its application; very little really is required if it is on the right spot; if it is on the wrong one, either the bleeding continues or it causes sloughing.

Pressure is also needed sometimes for other arteries which have been injured in parts that are peculiarly inaccessible. The internal pudic, for example, or some abnormal branch, may be wounded in lateral lithotomy in such a way that it cannot be secured; or one of the intercostals may be punctured by a stab. A dilatable india-rubber bag may be used for these. It must be introduced into the wounded part, inflated by means of a tube and then secured with a clip or stopcock. If this fails, digital compression for twenty-four hours may be tried, or some form of acupressure; but it must always be recollected that often in these cases the vessel is only punctured, and that complete division may bring the bleeding to an end at once.

If the artery lies in a bony canal (the descending palatine, for example, which has been wounded in the operation for cleft palate) hæmorrhage can only be stopped by plugging, using either a rounded splinter of wood, or, if the vessel is on the face of a stump, some wax or soap.

Elevation causes marked contraction of the arteries of a limb, and is very useful as an adjunct, but of itself it has little or no power, except over the bleeding from veins and capillaries.

It is still an open question, when there is distinct arterial bleeding from some deep-punctured wound, how far it is justifiable to trust to pressure. The alternative, enlarging the opening and trying to find the bleeding point, which may quite possibly lie on the other side of the limb (the posterior tibial, for example, has been wounded from the front), is often an operation of very great difficulty, and sometimes, from the circumstances of the case, simply impossible. Even when there is every assistance at hand, the attempt has often failed, and certainly unless all the conditions for a prolonged search are favourable, pressure is advisable, at least as a temporary measure. The progress of the case will generally determine whether further steps should be taken or not.

Acupressure is of great use in certain special cases. Occasionally, for example, an artery is embedded in such dense cicatricial tissue that it can neither retract and close, nor be isolated for ligature. I have on two occasions secured the posterior tibial in this way, when everything else had failed. Or it may lie in an aponeurosis, so that it is practically under the same conditions; or it may be so deep at the bottom of a wound, and close against the periosteum, that an extensive incision and prolonged dissection would be required to get near it. In such cases as these a curved needle may be passed beneath the bleeding point, and a figure-of-eight ligature placed over the two ends, as in the twisted suture, or a straight needle may be passed beneath or over the vessel, and then thrust into the tissues in a different direction, so as to close it by its pressure. The length of time it should be left depends upon the size of the vessel and the condition of the wound (fig. 33).

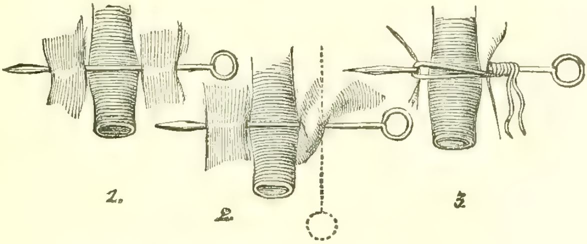


FIG. 33.—Different modes of applying acupressure.

Forcipressure is admirably adapted for securing with rapidity a number of small bleeding vessels. Catch-forceps are used with strong, bluntly-serrated ends; the bleeding point (with as little of the tissue round it as can be managed) is seized, the blades clamped together over it, and left for a few moments while the operation is continued or others are being caught. On removal the crushed end forms a flat band which does not open out again; the internal and middle coats, which are broken across by the pressure, curl up inside, and a coagulum forms at once. It is as efficient as torsion for all small vessels and much more rapid, and in many operations (such, for example, as excision of the breast) enables the use of ligatures to be dispensed with altogether.

Torsion.—When a limb is torn off the large vessels rarely bleed; the inner coats of the artery shrink up inside to such an extent that the end is completely closed and a coagulum forms at once. Torsion acts on the same principle. It may be carried out in different ways, unlimited or limited. In the former the end of the artery is seized with a pair of broad-ended, serrated forceps, clamped, and then twisted round as far as its natural connections allow, or sometimes twisted off altogether; in the latter the artery is drawn out in the same manner, but fixed with a pair of forceps placed upon it transversely about a third of an inch from the end, and this projecting part is twisted until it no longer uncoils itself (fig. 34).

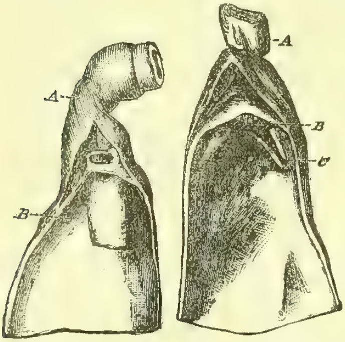


FIG. 34.—Effects of torsion upon an artery, showing the incurvation and laceration of the inner coats. From paper by Bryant, 'Med.-Chir. Trans.,' 1868.

There is no question as to the very great advantages that torsion possesses. It is better than forcipressure, for while the end is crushed in the same way into a flat riband, the internal and middle coats, instead of being merely broken off, are coiled up and rolled round together inside. There is no ligature to be absorbed (although now that catgut is chiefly used this is not so material), and temporary closure does not depend upon the security of a knot; in other words there is no fear of recurrent hæmorrhage from this giving way. The end of the vessel, if suppuration occurs, sloughs off it is true, but so it does with a ligature. If, on the other hand, the wound heals at once, it rapidly becomes organised into a cicatrix. For plastic surgery there is no doubt as to its superiority, for even catgut, however prepared, is a foreign body, and diminishes the chance of primary union. The largest vessels can be secured with perfect safety, and even when they are diseased, if the surrounding tissues are caught and twisted up with the end, a conical cap is formed which is sufficient to resist internal pressure until (unless nutrition is exceedingly feeble) organisation takes place.

Ligature.—This is the only method of universal application (although in many cases torsion or forcipressure is preferable), and the only one by which an artery can be safely secured in its continuity.

1. *When the artery is already divided.*—If the vessel is of any size, the end is seized with a pair of artery-forceps and drawn out from its sheath; if it is small it must be separated carefully from the adjacent tissues, and the ligature tied firmly round it in a reef knot. An attempt should always be made to divide the internal and middle coats, but care should be taken not to cut the artery through; the amount of force required is very slight. An internal clot begins to form almost immediately, and usually it reaches up the vessel as high as the next largest branch. Lymph pours out from the vasa vasorum and the capillaries in the tissues near; organisation begins, and, if the wound heals at once without suppuration, the end of the vessel, the sheath, and the tissues round it, are welded together into an inextricable mass of cicatricial tissue.

The fate of the ligature and of the portion of the vessel it surrounds depends upon the material and the way in which the wound heals.

Except in special cases, ligatures are made of finely twisted silk, soaked previously in a five per cent. solution of carbolic acid, or of catgut prepared with carbolic acid and kept in carbolic oil. It answers better if the catgut is hardened first, after Lister's plan, in chromic acid, as otherwise it is absorbed too soon. Silk, if the wound heals at once, is encapsuled in the cicatrix, the included portion of the vessel gradually becoming absorbed owing to the pressure round it; exceptionally, after lasting perhaps many weeks, the ligature gives rise to a certain degree of irritation, cuts its way through and comes out. Catgut, on the other hand, unless it is very old, disappears completely, the length of time it lasts depending upon its age, thickness, and method of preparation. If it has been tied tightly, the included portion disappears too; if loosely, it may remain unabsorbed, and then, at least in the case of an artery ligatured in its continuity, it becomes a source of weakness rather than otherwise. If suppuration sets in, the ligatures, whether of silk or catgut, come away, cutting through the vessel, and the distal end sloughs.

2. *Ligature of a vessel in its continuity.*—When an artery has to be tied *in situ* the conditions are very different from when it presents on the face of a stump. In the latter case the end is seen and drawn down from the sheath into which it has shrunk; the internal and middle coats are divided, and the artery begins to contract, as well as retract, at once. It has, comparatively speaking, lost a great deal of its importance; the femoral artery, for example, in a stump contracts almost immediately to less than half its previous diameter; the amount of tissue it has to keep supplied with blood is reduced, and though what is left has more work than usual, owing to the amount of repair, the blood-pressure falls proportionately. An artery tied in its continuity is under totally different conditions; two ends have to be closed instead of one; retraction cannot take place in the same way, and the pressure is not in the least diminished; there is as much tissue to be supplied after the operation as there was before.

The operation consists in exposing the artery at the selected spot (anatomical details chiefly determining where this may be); opening the sheath of the vessel, passing the needle round it with as little disturbance as possible; withdrawing it threaded, and then tying the ligature without lifting the artery out of its bed.

Repair is very much slower at the distal end than at the proximal: the internal clot is always smaller, and is often absent; retraction is much less complete, and secondary hæmorrhage, when it occurs, nearly always comes from this. Why it should is not so clear; the vasa vasorum are interrupted, but this alone will hardly account for it, and the arterial pressure on that side must be much lower than on the other.

Many attempts have been made to diminish this liability. Compression with a ligature has been tried, the internal and middle coats being carefully preserved from injury; and there is no doubt it succeeds in animals. A ligature that will last for some time without causing irritation is tied round the vessel, just tightly enough to close the cavity without dividing the coats; a coagulum forms inside, organisation follows, and before the ligature has lost its holding power, the lumen is completely sealed. Silk may be used for this purpose, but as it is always liable to cause a certain degree of irritation, a thick round cord of specially prepared catgut is preferred. Barwell has made use of a flat band, cut from the aorta of an ox, with the same idea. Probably kangaroo-tail tendon is better still, as it possesses great power of endurance, and can be secured more easily. In some cases a knot has been dispensed with, and the ligature fastened somewhat after the manner of a clove hitch; for there can be no doubt that when ulceration of the vessel-wall does occur, it usually gives way opposite the projection it forms. But these results, however good they have been, have not yet convinced surgeons that (except perhaps in the case of the innominate and common iliac) compression is safer than division. Too great force, it is admitted, should not be used; but a tight ligature is certainly safer.

There is more to be said in favour of a double ligature with division of the trunk between. If this is done, the ends retract at once (in the case of the femoral upwards of half-an-inch) owing to the elasticity of the vessel; and the condition is assimilated much more closely to that of ligature upon the face of a stump. Prepared silk, catgut, or kangaroo tendon may be used, and the ligature should always be tight. If there is no suppuration, the ends of the vessel and the portion of tissue included in the ligature are invaded by lymph, and replaced by cicatricial tissue. The permanent closure takes place by the organisation of the little button of exudation that is formed in the base of the internal clot, between the retracted edges of the inner and middle coats, and in the short contracted space between this and the ligature. If suppuration does occur, and the ligature cuts through, the more perfect retraction undoubtedly diminishes the danger.

Styptics are substances which either cause intense contraction of the vessels or hasten the coagulation of the blood. Perchloride of iron, turpentine, alum, subsulphate of iron and matico leaf are chiefly recommended; but, wherever it is possible, other remedies should be tried again and again instead. They altogether prevent union by the first intention, and cause a very great deal of inflammation. However, in some cases in which there is persistent rapid oozing which nothing seems to check, they do succeed. The surface of the wound must be rendered absolutely dry before any one of them is applied.

Choice of Method. 1. *When the artery is exposed on a stump.*—Small vessels contract under the influence of heat, cold, or exposure, and if pressure is applied afterwards give no further trouble. Forcipressure is useful for larger ones; torsion or ligature for the largest. Styptics, acupressure, plugging and other remedies are only employed under special conditions. Pressure and elevation should never be neglected. If the end of the vessel can be seen, it is safer to secure it with a ligature, even if it does not bleed at the time.

Whether torsion or ligature is the better when the walls of the vessel are diseased is an open question. If torsion is used, sufficient of the tissues round must be included to form a cap over the end. If ligature, a broad and rather stout strand of catgut should be chosen and some of the tissues round should be included so as only to compress the vessel; a tight ligature would cut it in two at once. The great hope in these cases lies in early union; the ligature or the twisted end of the vessel can be relied upon for a week or ten days. If union round the artery is fairly sound at the end of that time, it is probably sound inside as well, and the organised coagulum will hold; if suppuration takes place, or if nutrition is so feeble that organisation fails, the end of the artery perishes, and secondary hæmorrhage is only too probable.

2. *When an artery is injured in its continuity.*—If it is exposed at the bottom of a wound, bruised but not divided, two ligatures should be placed

upon it, one above, the other below, and the trunk severed between. When it is wounded, this rule is imperative, for if one end only is tied, the other bleeds profusely as soon as the collateral circulation is established, and though the stream may not be so forcible it is equally persistent.

If it is not exposed and the hæmorrhage is severe, a tourniquet must be placed upon the trunk higher up, and the wound enlarged by careful dissection until the bleeding point is found. If this is not done, it is impossible to be certain whence the hæmorrhage comes. Tying the trunk of the vessel higher up, even supposing it were certain to be the right one, does not succeed; either the collateral circulation is good, and then secondary hæmorrhage occurs from the distal end; or it is bad, and gangrene results.

To these rules, however, there are a few exceptions:

1. Punctured wounds of the tonsil, or behind the angle of the jaw with severe arterial hæmorrhage. Exposure of the bleeding point by dissection is out of the question; the common carotid must be tied in the hope of checking the hæmorrhage. It has been recommended to tie the external too, just above the bifurcation, with a view of cutting off a large amount of the collateral supply.

2. Punctured wounds of the deep palmar and the plantar arches must be treated by pressure, as already described.

3. If the vertebral is injured, it is generally better to trust to packing from the bottom with iodoform gauze, than to attempt ligature. The diagnosis, however, at the root of the neck is impossible without some exploration; and it may occasionally happen that the artery can be secured there.

4. Very deep punctured wounds, in which it cannot be determined what has been injured or where it has been injured, are probably better treated by pressure, at any rate for a time, especially if the light is not perfect and thorough assistance not at hand. There is no telling, in such cases, if the operation is once begun, where it is likely to stop.

5. In cases in which one of the limbs has been disorganised from cellulitis, or a sequestrum has ulcerated into a vessel, amputation may have to be performed. These, however, are to be judged upon their own merits; it is not merely the loss of blood or the risk of secondary hæmorrhage, but the fact that the limb, if it were saved, would be useless afterwards, that determines the operation.

When an artery has been ligatured in its continuity, the greatest care must be taken to avoid gangrene. The limb should be wrapped in cotton-wool from one end to the other; surrounded with hot-water bottles (not too close); and slightly raised so as to assist the circulation as far as possible. Bed-sores form in these cases with unusual rapidity, and healing is very protracted. Afterwards, the wasting of the tissues, and particularly of the muscles, is often very considerable, and if the artery was an important one, and the patient past middle life, the size and strength of the part never thoroughly return, and it remains cold and liable to chilblains and chronic ulceration for the rest of life.

If the collateral circulation fails from atheroma of the arteries, weakness of the heart, external pressure, or a great transverse wound dividing many branches, gangrene ensues. If it is of the moist variety amputation must be performed; fortunately, however, it is usually dry, and then the patient may escape with the loss of one or two fingers or toes, as the case may be.

Defective Repair

Repair may prove defective at different periods and under different conditions ; in every case it leads to hæmorrhage, which may be external (recurrent and secondary) ; or internal (arterial hæmatoma, traumatic aneurysm, arterio-venous aneurysm, and aneurysmal varix).

1. *Recurrent Hæmorrhage*

This usually occurs within the first few hours, rarely or never after four and twenty, and it is always traceable to failure in some of the measures upon which temporary arrest depends. A ligature may have slipped ; some artery may have been overlooked from its not bleeding at the time ; a clot may have been displaced by some accidental movement ; or an artery may have been injured without being opened. In any case, when the heart regains its power the hæmorrhage returns, at first quietly and then seriously, especially if the wound is covered up with a thick layer of loose absorbent dressings.

The treatment depends upon the amount. If there is merely slight oozing, an attempt may be made to check it by pressure, cold, and elevation. If this fails, or if the amount is serious, distending for example the flaps of an amputation, the patient must be placed under an anæsthetic, the wound laid open, and the bleeding point secured as in primary hæmorrhage, following the same rules.

2. *Secondary Hæmorrhage*

This is due to failure in the measures by which permanent arrest is effected. Either the amount of lymph poured out is insufficient ; or it does not become vascularised and organised in time ; or, owing to the presence of some additional irritant, inflammation sets in, impairing the nutrition, not only of the newly formed lymph, but of the vessel-wall as well. Whatever it is, whether the artery is on the face of a stump or has been tied in its continuity, a slight amount of blood-stained discharge is noticed one day, usually about the time the ligature takes to cut through the vessel ; the next there is a little more ; and then suddenly, from some accidental exertion, coughing or straining at stool, there is a furious outburst. Fortunately there is nearly always a warning.

Causes.—Secondary hæmorrhage is due to the same causes that delay healing of wounds in other structures.

(*a*) *Constitutional.*—Pyæmia, septicæmia, renal disease, and other conditions that interfere with all reparative processes, strongly predispose to it.

(*b*) *Local.—Malnutrition of the wall of the vessel*, whether arising from atheroma or because it has been separated from its sheath. Clearly, if the wall of an artery is already badly nourished, it is not likely to repair the results of an injury readily.

The addition of some other irritant is the most common cause of all. The ligature itself is one, although it may be very slight ; but with this already present only a little more is required, and that little is easily supplied. Want of rest is a common cause, straining, rough transport, or rough handling for example ; the neighbourhood of a large collateral branch with its constant pulsation is another ; but by far the most important is the presence of suppuration. If this occurs in a wound it always attacks the weakest issues, those already injured by a ligature : the wall of the artery becomes soft and yields, and organisation in the inner clot fails. For this reason, secondary hæmorrhage is much more common in wounds that are complicated by suppuration then in those that are repaired without.

Premature yielding of the ligature is very serious. In animals no ligature is required ; it is sufficient if the inner and middle coats are divided so that they can curl up ; or if a ligature is used, it simply need be placed round the vessel so as to compress it ; but in man this cannot be relied upon. If the ligature yields too soon, whether it is prematurely absorbed or the knot gives way, the outer wall loses its support before the internal organisation is complete, and then there is always danger of the protecting barrier failing and secondary hæmorrhage taking place.

Treatment.—This depends upon whether the artery is on the face of a stump or has been ligatured in its continuity.

(*a*) *On a stump.*—Pressure and elevation should be tried first, but if it continues the bleeding point must be sought and found, even if it is necessary to open up the flaps again and break down all, or nearly all, the union. The only exception is when the stump is almost healed, and it is tolerably clear from the effects of pressure that it is either the main vessel itself or an immediate branch. In these circumstances the brachial may be ligatured for an amputation immediately below the elbow, the subclavian when the limb has been removed at the shoulder-joint, and the common femoral if at the hip.

If the stump is sloughing (as it often is in these cases) the artery must be dissected up some little distance and tied well above the infected part. The actual cautery answers for the time, but if the vessel is of any size it cannot be relied upon.

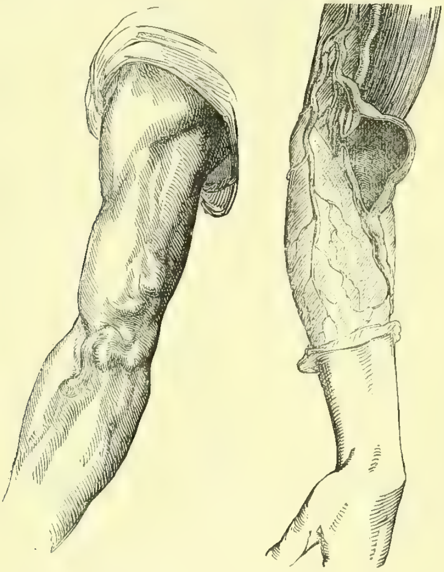
(*b*) *When an artery has been ligatured in its continuity.*—Rest, cold and pressure should also be tried here first, but if the warning is repeated, or if the loss is at all considerable, it is better not to delay further. It is true that some cases have lived through repeated hæmorrhages and have recovered, but many more have died ; and there can be no question, so far as the lower limb at least is concerned, that the wound should be opened up (a tourniquet eing placed on the vessel above), the two ends deliberately dissected clear nd ligatured. In the upper limb, the artery (especially the brachial) has een tied nearer the trunk with occasional success, but the anatomical onditions here are very different. If this treatment fails, amputation must e performed.

3. *Arterial Hæmatoma*

This condition is exactly equivalent to that of an artery ruptured subcuaneously, and must be treated in the same way. There is no sac, simply a videspread extravasation with, if the vessel is a large one, interruption of he circulation and threatening gangrene beyond. If it is the axillary, an ttempt may be made to turn the clot out through a free incision and tie oth ends. If the femoral or the popliteal, and the patient is young and the est of the arteries healthy, the same may be done : but if the conditions re not perfectly favourable in other respects, amputation is the only hope.

4. *Traumatic Aneurysm*

Sometimes, when repair is incomplete, a traumatic aneurysm forms in he same way as after partial rupture. Either the cicatrix or the injured oats are not sufficiently strong to resist internal pressure, or they are not supported well enough from outside, and they gradually yield and stretch. It is only so long as the aneurysm is very small that the relation they bear to it can be traced; as soon as it forms a perceptible enlargement the tissues that surround it, consolidated by the pressure and thickened by slight inflammation, constitute the outer part of the wall, while the inner surface, as in aneurysms that result from disease alone, is lined with laminated fibrin. The course, terminations, and signs of a traumatic aneurysm are identical with those of the ordinary variety; the difference consists in the condition of the rest of the wall of the vessel. As it is perfectly healthy quite up to the sac itself, ligature may be practised in any part, near it or far from it, above or below, that offers the best prospect of cure. Many of these, however, recover without operation, under pressure or flexion.



FIGS. 35 and 36.—Aneurysmal varix.

5. *Arterio-venous Aneurysm*

This and the remaining form, aneurysmal varix, are met with under the same condition, when an artery and a vein have been wounded at the same time and place, and repair has not been perfected.

In aneurysmal varix there is no sac, merely the direct communication of an artery with a vein; the artery is somewhat dilated above, much contracted below, while th vein is enlarged, thickened tortuous in all directions an pulsates strongly. The lim below is usually wasted, but i may be enlarged and in a stat of solid œdema. There is peculiar purring or buzzin sound to be heard over it, pr pagated along the veins t wards the trunk (figs. 3 and 36).

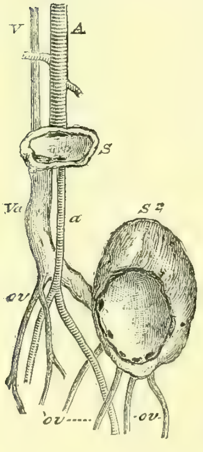


FIG. 37. — Mr. Cock's case of arterio-venous aneurysm.

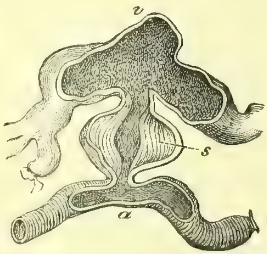


FIG. 38.—Aneurysm laid open. *s.* The laminated clot in the sac.

Arterio-venous aneurys on the other hand, has a sa developed chiefly from the tissues that form the channel of communicati between the two vessels; and the aneurysmal symptoms are more marke the venous ones less distinct (figs. 37 and 38).

The most common situation is at the bend of the elbow, owing to acciden during bleeding, but they may occur elsewhere, especially from sword-thrusts. Aneurysmal varix should not be interfered with; an elastic support may be worn to keep it in check, but nothing further. Arterio-venous aneurysm, on the other hand, should be treated as an aneurysm, first by pressure upon the artery above and upon the vein, and then, if this fails, by ligature.

INJURIES OF VEINS

Veins, like arteries, may be bruised, torn or wounded; but except under special conditions, serious bleeding rarely follows.

Contusions.—Thrombosis of a vein occasionally follows bruises and strains without any extravasation having been noticed. Probably the internal coat has been injured; coagulation has taken place; and the clot has continued to grow until it has filled the interior. Owing to the freedom of anastomosis, serious obstruction is unusual.

Laceration.— Subcutaneous laceration of small veins is of common occurrence, but the pressure is so low that the vessels close and the hæmorrhage ceases, before a dangerous amount of blood is lost. If, however, the trunk is a large one, or a branch is pulled off from the side, and the tissues round are soft and yielding, as in the axilla, the amount of extravasation may be sufficient to cause gangrene or even threaten life.

Wounds.—Punctured wounds and small incised ones that run in the direction of the vessel should be sewn up with a continuous catgut suture; the interior usually remains patent, but occasionally a coagulum forms and thrombosis occurs. If the wound is transverse, unless it is very small, the vessel should be tied above and below, and the division rendered complete.

Small veins if cut in two collapse immediately. Large ones may cause a serious loss of blood from the proximal end; and if there is any compression on the cardiac side of the wound, or if the vein is varicose or dilated so that the valves cannot act, the hæmorrhage may prove fatal within a comparatively short space of time. Ligature is only required in the case of the largest trunks, and then as a precaution; but it can do no harm, and it does not cause phlebitis. Elevation, or the slightest degree of local pressure, is almost always sufficient.

Gangrene of a limb rarely follows ligature even of the chief vein, owing to the freedom of anastomosis. Sometimes there is a certain degree of venous obstruction followed by tension and solid œdema, but it is by no means invariable. The axillary, for example, is not unfrequently ligatured in excisions of the breast without any ill consequence, so long as the lymphatics are not obstructed; and the same may be said of the femoral. When the chief artery of a limb is wounded at the same time, the risk is greater, but the external iliac artery and vein have been tied simultaneously without any bad result; and this has happened on many occasions in the case of the femoral. Probably it is safer, when such an operation is required, to delay it as long as possible with the view of encouraging the collateral circulation, but this is by no means essential and of course is impracticable in the case of a wound.

Entrance of Air into Veins

This exceedingly dangerous accident rarely occurs except in connection with the great veins of the neck. In these the pressure during inspiration is negative, and the blood is sucked into the thorax. Under the ordinary conditions they are partly filled from behind, partly closed by the collapse of their walls. If inspiration is very deep, or their coats are thickened, or if as often happens while deep-seated tumours are being removed, they are held open by the traction upon the cervical fascia which invests them, and at the same time an accidental opening is made in their wall, air is sucked in with a peculiar hissing, gurgling sound, and the right auricle is filled at once with a bright frothy mixture.

The consequences depend upon the amount. If it is at all considerable death is instantaneous; the frothy mixture cannot raise and close the valves and the circulation comes to an end. Where it is not sufficient for this, the patient suddenly becomes pale and livid, the pupils dilate, the pulse is small and flickering, the respiration hurried and gasping, and the heart's action violent and irregular. As the air is dissolved this passes off, and gradually the heart begins to beat with regularity again, but the danger is not all over, for sometimes, even after some hours, alarming symptoms suddenly return. Possibly this is due to the air having entered the pulmonary capillaries, but more probably to the shock.

This accident usually occurs in operations about the root of the neck; but it has been known to happen in wounds of the axillary and even more distant veins. The greatest care must be taken in all operations about this region, especially as it is often necessary to exert a good deal of traction upon the structures, lifting them well up to see what is beneath. Any vein that is exposed and requires division should be ligatured first; and, as Treves suggests, a basin of water and a sponge should be placed by the side of the patient's head, that at the least sign the wound may be filled at once.

If the peculiar hissing sound that characterises this accident is heard, either the finger or the sponge full of water should at once be placed upon the vein, regardless of everything else, and the patient's thorax compressed. Possibly by this some of the air may be forced back again. Artificial respiration should not be employed, but every attempt should be made to keep up the action of the heart and to maintain a sufficient supply of blood to the brain, by the hypodermic injection of stimulants, and by lowering the head and raising the limbs.

SECTION II.—DISEASES OF BLOOD-VESSELS

ANGEIOMA

Angeiomata are tumours composed entirely, or almost entirely, of blood-vessels. For the most part they are congenital; many, however, are not noticed for a month or so after birth, and arterial ones may not make their appearance until much later. They may be composed of arteries, veins, or capillaries, or of all three together. Sometimes they consist merely of already existing vessels enormously dilated and varicose; more often of newly-formed ones as well, and certain varieties are not unfrequently associated with other forms of congenital growth.

Capillary angeiomata (cutaneous nævi) have been noticed already among diseases of the skin.

Venous angeiomata (subcutaneous or venous nævi) may occur in conjunction with capillary ones or independently, either in the subcutaneous tissue or in other parts. Some of them appear to be formed merely of dilated veins, others resemble rather the cavernous structure of the penis, being composed of irregular, thin-walled spaces in direct communication with arteries, and these may be associated with congenital lipomata, blood and serous cysts, and occasionally with rapidly-growing sarcomata. As a rule venous nævi form soft, irregular, but distinct masses, easily compressible, and filling up again as soon as the pressure is removed. Some few of the cavernous ones merit the name of erectile tumours, but there is very rarely any pulsation to be detected. Their colour varies with their position. If beneath the skin they are blue, like veins; if under a mucous membrane, bright red; and their consistence varies of course with the amount of solid growth that is present. In many cases they remain stationary for years, not unfrequently they degenerate or become cystic; sometimes, after lying unaltered for a great length of time, they suddenly enlarge, ulcerate, and give rise to severe hæmorrhage. Venous nævi must be carefully distinguished from meningocele or encephalocele when they occur at the root of the nose or at the angles of the orbit; and if there is the suspicion of a doubt, the tumour should certainly not be touched.

Various methods of treatment may be adopted, according to the size, position, and rapidity of the growth of the tumour. Probably, if in a part of the body in which they are not seen, and if there is no evidence of increase in size, the best plan is to leave them alone, certainly for a time. Excision is the most certain, and leaves an exceedingly small scar; the amount of hæmorrhage is very slight. Electrolysis (using only the positive pole) is tedious but safe, and leaves no mark at all. The constant current should be used, four or six cells of Stohrer's battery. The negative pole is attached to a metal plate covered with wash-leather; the positive to one or more steel-tipped needles, insulated for about half their length. These are introduced into the nævus, parallel to each other. As soon as the current is turned on the blood begins to coagulate round them, and when they are withdrawn, a hard dense track is left. If bubbles of gas make their appearance, it is a sign that the current is too strong. Where a rapid effect is desired the actual cautery is the most successful application. One perforation is made in the skin, and then the fine platinum point is thrust through the substance of the growth in various directions. If it is of the right temperature the pain is very slight, and no blood is lost. In other cases setons may be employed; or threads dipped in perchloride of iron; or portions may be ligatured subcutaneously; or the growth may be divided in various directions with a tenotomy knife, and pressure applied afterwards. In cases in which extensive nævi are associated with rapidly increasing solid growths in children, the outward application of strong lead lotion is of decided benefit, at any rate for a time. Injections should never be used, for fear of causing embolism.

Arterial angeioma (arterial varix, cirsoid aneurysm, and aneurysm by anastomosis, are other terms descriptive of essentially the same condition) is, in comparison with these, of very rare occurrence, and, though it may be congenital in some instances, is seldom met with before puberty.

It is known as arterial varix when only a single artery is involved; as cirsoid aneurysm if there is a mass together; and as aneurysm by anastomosis when the capillaries and venules are dilated as well.

The most common situation for it is the scalp (especially round and above the ear), but it may occur in any part of the body. Sometimes it is stated to have developed from a nævus; in other instances it appears to have followed injury, and possibly may have originated as some form of arteritis; in the majority no reasonable cause or explanation is forthcoming (fig. 39).

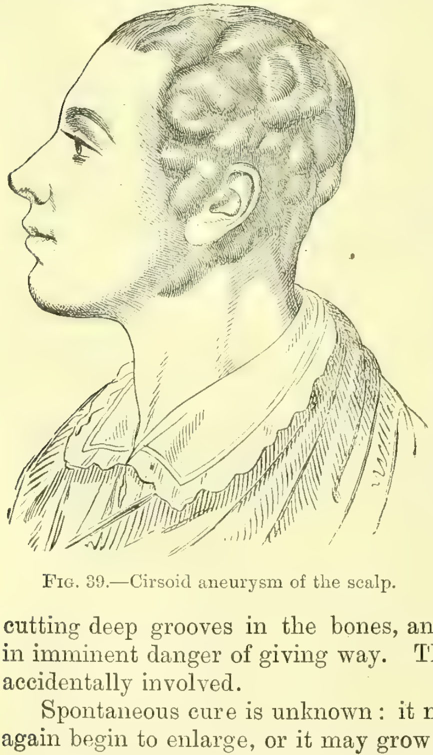


FIG. 39.—Cirsoid aneurysm of the scalp.

In its typical form it is composed of a mass of enormously dilated, tortuous arteries, twisted inextricably together and covered with thin-walled pouches. It projects somewhat above the skin (which is often dangerously thin over the most prominent parts); it is soft, lobulated, easily emptied by direct pressure, and to a less extent by pressure upon the trunk supplying it; but it fills again at once, and its outline is very ill-defined, the branches that supply it only assuming their normal character some distance from the main body. A thrill and a distinct bruit can be detected over the main part, and followed along the vessels in the course of the blood-stream. By its pressure it gradually causes absorption of the structures round, cutting deep grooves in the bones, and rendering the skin so thin that it is in imminent danger of giving way. There is no pain unless some nerve is accidentally involved.

Spontaneous cure is unknown: it may remain passive for years and then again begin to enlarge, or it may grow steadily the whole time. If the skin gives way the hæmorrhage is of the most alarming character, and may prove almost immediately fatal.

Excision is the only treatment that deserves any reliance. Ligature of the trunk supplying the tumour has failed far more frequently than it has succeeded, and renders subsequent operations more dangerous on account of the development of the collateral circulation. Pressure checks advance in some of the more chronic cases, but can do no more. Ligature *en masse* has answered in a few instances, although in one at least recurrence took place.

If it is on the scalp temporary ligatures may be placed on the carotids, or the trunks supplying the tumour may be compressed with hare-lip pins, and then, with the aid of one or two assistants to keep up digital compression while the ligatures are being placed and tied, the skin may be reflected from part of it, and the rest of the growth excised with the minimum of loss. If it is on the extremities the same plan may be tried, but in several cases amputation has been found necessary, sooner or later.

HÆMOPHILIA

Hæmophilia, or the hæmorrhagic diathesis, is a peculiarity of constitution that is distinctly hereditary; but though it may be transmitted by mothers to their sons, it is very rarely manifested except in males. Female children themselves are very seldom affected.

Nothing is known as to its cause; no definite change is found constantly in the walls of the vessels, and there is no apparent alteration in the blood. At first it coagulates as readily as usual, and though after a time it becomes thin and watery, the same thing occurs after profuse hæmorrhage from people who are not bleeders. The aspect or appearance is not in any way characteristic, and beforehand there is nothing to tell whether a patient is a bleeder or not. The tendency to it is most marked in infancy and childhood; if it does not develop then, the patient as a rule remains free. In a few instances it seems to have spontaneously died out, and in all probability the tendency to it varies in intensity at different times.

In some the bleeding is spontaneous, coming from mucous or synovial surfaces, in others it is traumatic only. The slightest injury may cause it; bruises are followed by enormous extravasations in which the blood remains fluid for a great length of time, and the extraction of teeth is especially serious. It is said that trivial injuries are more often followed by bleeding than grave ones, but this is open to question. It is not arterial or venous, the blood simply appears to pour out from the tissues themselves in a ceaseless stream.

Spontaneous hæmorrhages are stated to be often preceded by symptoms of congestion, but they more usually occur without warning. When the joints are involved it is not unfrequently taken for rheumatism, especially as there is a decided tendency for it to occur in cold and damp weather. The swelling is sudden, involving the peri-synovial tissues as well as the cavity of the joint and accompanied by ecchymoses. Permanent enlargement and even ankylosis may follow if the attacks are repeated. The mucous membrane of the nose, and that of the gastro-intestinal tract are the most frequent seats, but in some the bleeding comes from almost every part.

No special treatment is of any avail. Internal styptics have been used freely, and every kind of external one, without success. Not unfrequently the patient continues to lose blood until not a drop seems to be left, and then rapidly begins to recover; but they rarely reach old age or even adult life. In the case of teeth, carefully applied pressure is the most successful; a cork should be fitted into the hollow, the cavity thoroughly packed, and then the teeth of the other jaw pressed tightly against it by means of a webbing strap round the head. In this way I have succeeded in checking it in several members of a well-known family. The actual cautery seems to be of no special use, and of course no measure that involves a wound should ever be attempted.

DISEASES OF ARTERIES

Inflammation

Arteries, if subjected to long-continued irritation, become inflamed like other structures, the character of the inflammation depending upon the cause. It may commence in the intima (endarteritis), the media, or the sheath (peri-arteritis) and it may be acute or chronic, the exudation becoming absorbed, undergoing organisation, degenerating, or being transformed into pus, according to the persistence and intensity of the irritant.

1. *Simple Traumatic Arteritis*

The best example is that caused by a ligature; the minute vessels in all the parts around dilate, lymph pours out, the amount depending very largely upon the nature of the irritant; some is absorbed, the rest becomes vascular and is organised into a cicatrix. If the ligature disappears without causing a sufficient degree of irritation, or if the tissues are so badly nourished that they are unable to carry out active repair, the cicatrix is very likely to be too weak and to yield to the strain that falls on it.

Similar changes occur after wounds, bruises, and the impaction of non-infective emboli.

2. *Suppurative Arteritis*

This may begin in the interior from the presence of an infective embolus, or on the exterior, as peri-arteritis. In the latter case the organisms generally enter through a wound, but when, for example, there is a suppurating aneurysm, they must reach the part either through the blood-stream or the lymphatics; the constant pressure and tension irritate the tissues and break down their power of resistance, and the pyogenic germs, which otherwise are innocuous, at once begin their work of destruction.

In pyæmic embolism, whether infarction occurs or not, the destruction is so rapid and so general that the changes in the wall of the artery cannot be distinguished, the tissues melt at once into intensely infective pus. When, however, the suppuration begins in the outer coat, after ligature for example, the course of events can be traced fairly well. The vasa vasorum dilate and become sheathed with leucocytes, the fibrous tissue melts away, the muscular bands split up, the endothelial cells perish and become detached, and at length, although the wall of an artery resists better than most structures, it is gradually eaten through or so weakened that it gives way. As a rule, before this occurs, the white corpuscles collect upon the inflamed wall and form a protecting thrombus.

The subsequent course depends upon the intensity of the irritant on the one hand and the activity of nutrition upon the other.

(*a*) If there is no additional cause at work, no tension, mechanical irritation, or absorption of septic products, the suppuration may cease, the tissues gaining the upper hand, and the wall of the artery remain intact, as for example usually occurs when a vessel is exposed upon the floor of a simple ulcer; or the result may not be quite so good; one part of the wall, for example, may be so weakened that it yields and forms an aneurysm, or the interior may be completely closed by a thrombus, or part of the artery may perish and slough, loss of blood being prevented by the sealing of the ends.

(*b*) If, on the other hand, the vitality of the tissues is too much impaired for organisation to be effectual (as in phagedæna), or if some other irritant appears upon the scene (especially septic decomposition), the germs prove themselves the stronger, and the tissues give way. The wall of the vessel is softened, the clot disintegrates before it is organised, and secondary hæmorrhage occurs.

This accident may happen when a wound heals by the first intention, and even after it has healed, if the cicatrix is thin and weak, and the structures around soft and yielding; but it is much more common after suppuration, especially if the nutrition of the tissues is impaired, whether from pre-existing atheroma or from septic decomposition.

A special form of embolic arteritis is met with in connection with ulcerative endocarditis. The vegetations detached from the valves sometimes cause suppuration, as in pyæmia; but not unfrequently they merely give rise to a certain degree of softening and inflammation, by which the walls of the vessels are unduly weakened. In all probability a very large number of the aneurysms that occur in young children may be accounted for by this, the dilatation beginning opposite the embolus, not above it.

3. *Syphilitic Arteritis*

Arterial disease is of common occurrence both in acquired and hereditary syphilis, especially in the brain. Probably the apparent frequency with which this organ is involved may be explained by the gravity of the symptoms that follow, by the fact that its vessels are easily examined, and by the anatomical peculiarities of their lymphatic sheath. Usually single vessels only are affected and often only small portions of them (fig. 40).

The exudation is similar to that which occurs elsewhere, with, however, a special tendency to fibroid transformation; it is doubtful if it ever calcifies. Sometimes it commences as a peri-arteritis, distinct gummata forming on the vessel and occluding it more or less by their pressure; more frequently, however, it involves the deeper layers of the intima, causing such an enormous degree of thickening that the interior of the vessel is almost closed. If the endothelial lining is involved as well, a thrombus forms over the affected part, and renders this complete. In the brain this may lead to white softening,

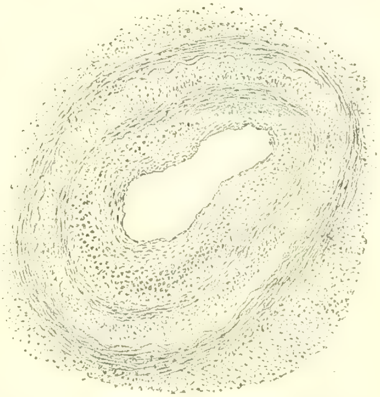


FIG. 40.—Syphilitic disease of one of the cerebral arteries. The inner coat is thickened by fibrous tissue, and the lumen is much narrowed. (Bowlby.)

from the blood-supply being cut off, or to aneurysm. In the most fortunate examples the exudation is absorbed again more or less completely, leaving, however, the vessel tortuous, inelastic, and weakened, so that it is always liable to give way.

Similar changes are found in the vessels of gummata, and it has been suggested that the consequent diminution in the amount of blood they receive is the immediate cause of the degenerative changes they undergo as soon as they reach a certain size.

4. *Arteritis Obliterans*

This name has been given to a peculiar form of inflammation, which sometimes occurs in arteries during middle life. Nothing is known as to its pathology. It is exceedingly chronic in its course, beginning in the smaller vessels and steadily involving the larger ones, causing them first to become hard and thick, and then gradually closing them. It is often accompanied by very severe pain and usually ends in dry gangrene. When it occurs in younger subjects, especially in the arm, it is very liable to be confused with occlusion of the artery caused by deep-seated growths, especially cervical exostoses.

5. *Gouty Arteritis*

A few cases are recorded in which a moderately acute attack of periarteritis has occurred in gouty subjects past middle life, possibly, therefore—as syphilis, injury, and all ordinary causes could be eliminated—due to gout. It has been noted in the temporals with a certain degree of redness of skin and tenderness over their course, and in the brachial. Usually it ends in thrombosis and obliteration, the ultimate consequences, of course, varying with the collateral circulation.

Tubercular infiltration of the perivascular sheath of the cerebral arteries is of common occurrence, and certain facts render it probable that occasionally tubercular masses rupture into arteries and cause embolism (especially in connection with the bones), but no definite tubercular arteritis has yet been described.

6. *Chronic Arteritis or Atheroma*

Chronic inflammation, with its consequence, atheroma, is very common in late adult life, although probably its beginning is laid at a much earlier period. The larger vessels are chiefly affected, and those parts upon which the strain is greatest, the arch of the aorta, for example, the origin of branches, the spot where the external iliac becomes the femoral, and generally the convexities of all the curves; but the arteries of the brain, especially those at the base, those of the lower limb, and, in the abdomen, the splenic, suffer almost as often.

It can be traced to the effect of strains, sudden or long-continued. It is more frequent in men than women, it affects those especially who have to undertake suddenly great physical exertion, and it involves those parts of the vascular system which are the first to feel such effects. The pulmonary artery, for example, is always exempt unless there is some obstruction to the flow of blood through the lungs, causing hypertrophy of the right ventricle; then it suffers equally. Alcohol helps to produce it, and so do plethora and gout, for much the same reason, but it is doubtful if syphilis has more than an accidental connection. Bright's disease and arterio-capillary fibrosis are especially likely to be followed by it.

Its first appearance is as a grey semi-translucent spot, slightly raised above the surface ; this grows larger and larger, coalesces with others like it, becomes more yellow in colour, and at length forms a distinct elevation, elongated or circular in shape, according to the part of the artery in which it is situated. It is caused by an inflammatory exudation into the subendothelial cellular layer, immediately under the lining of the vessel. Probably it begins here, partly because the texture is somewhat looser than elsewhere, partly because it is the first to feel the strain. The middle coat is but little affected until the muscular fibres begin to waste, then it yields, loses its elasticity, and becomes rigid. The outer, on the other hand, is usually involved nearly as much as the inner.

In some instances the exudation may disappear again, leaving the wall intact, but of this naturally there is no evidence. As a rule it either becomes fibrous, forming firm, slightly raised, yellow patches, still covered with endothelium ; or undergoes degeneration, either fatty or calcareous, or both together. Not unfrequently the outer portion becomes organised, while the inner decays.

The reason of the difference is probably to be found in the condition of the blood-supply. The vasa vasorum ramify in the outer and middle coats, but do not supply the sub-endothelial layer, this is nourished chiefly or entirely by diffusion through the endothelium. When inflammation sets in, and the lymph-corpuscles increase in number, so simple a process as this is insufficient, and degeneration begins before new vessels can develop. On the other hand, in the outer layers, where the blood-supply is much more abundant, organisation is the rule.

Fatty degeneration is marked by a change in colour and consistence. The patch becomes more yellow, it grows softer and softer, so that in extreme cases it is almost fluid, and then suddenly the endothelium gives way, and the contents—fatty molecules, cholesterin, and crystals of stearin—are discharged into the vessel. Fortunately they do no harm, beyond blocking up perhaps some minute branch ; but an *atheromatous ulcer* is left, an excavated, ragged spot, often of considerable size, with the endothelium gone, the tunica media softened and weakened, and the integrity of the vessel only maintained by the thickened, inelastic outer coat, which is fused with the structures round.

Calcareous degeneration is usually secondary to this, the fluid part disappearing, and the caseous débris left becoming infiltrated with lime-salts until it forms an irregular plate, lying in the wall of the vessel, exposed more or less to the blood-stream, and not unfrequently projecting into it at some point.

The appearances produced by these changes are naturally very variable. The artery may be dilated along its whole course, or here and there ; not unfrequently it is elongated and tortuous, while the walls are rigid and inelastic, thickened in places and tied down by adhesions to the sheath, dangerously thinned perhaps in others. The inner surface is still worse : in some parts there are firm, raised nodules of a greyish colour, still smooth ; in others the endothelium has given way, leaving a ragged excavation with fringed and overhanging edges, lined with caseous débris or calcareous plates, and in others again the irregularities are concealed beneath adherent thrombi. Rupture sometimes occurs in the arteries of the brain in which the adventitia is poorly developed ; elsewhere it is unusual, as the outer coat becomes thick enough to resist.

The loss of elasticity and the destruction of the surface are soon followed by worse results. The walls stretch and yield, the vessels are thrown into curves and loops, so that what is known as a locomotive pulse is produced; the parts beyond are ill-nourished and ill-supplied with blood, and as enlargement of the collateral circulation is impossible, the least difficulty is liable to be followed by gangrene. It is by far the most common cause of aneurysm, sacculated as well as dissecting. If, as usually happens, one part of the wall becomes weak and soft from inflammation, without an extensive degree of atheroma, the sacculated form is produced. If, on the other hand, degeneration occurs at an early period, so that the lining membrane ruptures before the coats are welded together, the dissecting one follows, and the blood works its way down, between the layers of the wall, until it either bursts into the vessel again, or breaks the outer coat and pours into the tissues round. Thrombosis is even more common, the blood coagulating upon the irregular projections, and perhaps completely occluding the vessel. Embolism may occur, or the orifices of the small branches (the coronary arteries, for instance) may be closed by the contraction of the fibrous tissue round them; or rupture may take place, or, in short, almost any of the troubles that can happen in connection with the blood-vessels or the blood-supply.

The importance of atheroma in the production of secondary hæmorrhage cannot be over-estimated. Clearly, if the walls of the vessels are badly nourished and inflamed already, immediate repair after injury is hardly probable. Fortunately the change is often local, and if, for example, the popliteal is diseased, the femoral in Hunter's canal may be sound.

DEGENERATION OF ARTERIES

The coats of arteries are liable to degenerate and decay as age advances without any preceding inflammation, although naturally the two are often associated, and the same thing is met with in younger people as a result of marasmus, anæmia, and exhausting illnesses.

Fatty Degeneration

Fatty degeneration of the intima is not unusual in the aorta; apparently it begins in the stellate sub-endothelial cells of the intima, and forms opaque yellow, sharply outlined patches, which may be distinguished from atheroma by the fact that they are superficial and scarcely raised. The deeper parts are quite healthy. It has no clinical importance.

When, on the other hand, it involves the media, especially in the case of the brain, the wall is so weakened that there is imminent danger of rupture.

Calcareous Degeneration

This is especially liable to occur in the cerebral arteries and in the tibials of old people. It involves the middle coat chiefly, and appears to be a primary calcareous degeneration of the unstriped muscle-cells. They gradually disappear and are replaced by calcified rings, which fit so closely together and are so numerous that the artery becomes converted into a calcified tube. Ultimately the intima is affected too, but this does not occur so early or so extensively as in atheroma; the adventitia sometimes becomes hypertrophied so as to form a protecting sheath; sometimes, on the other hand, it wastes away and nothing but these calcified rings is left. The effect upon the circulation is, of course, exceedingly grave: the loss of elasticity impedes the flow of blood and prevents any variation in the supply, the roughness of the surface increases the friction, the diameter is diminished by the increased thickness, there is always imminent danger of thrombosis and embolism, and the establishment of a collateral circulation is usually impossible. As might be expected, it is the most important factor in the causation of senile gangrene, especially the dry form.

In addition to these changes the arteries of old people are often immensely elongated and tortuous without there being any evidence of atheroma, fatty degeneration, or, as it is often met with in those who are ninety years of age and over, of renal disease. In all probability this condition is due to the gradually failing power of the muscular walls of the vessel, and to the loss of support from the structures round; for it is most marked in those whose limbs are greatly wasted. Usually it is associated with a certain degree of fibrous thickening, so that the vessel is unusually distinct to the touch, but probably this is to be regarded as a compensative hypertrophy; it is not the result of inflammation or of unduly high vascular tension.

DISEASES OF VEINS

Varicose Veins

Veins are described as varicose when they are habitually distended and dilated beyond their normal size. This is most common in the lower limb and in connection with the spermatic and hæmorrhoidal plexuses (varicocele and hæmorrhoids), but it may occur in any part of the body.

Causes.—Varicose veins are caused either by an increase in the blood-pressure, or by a diminished power of resistance in the walls, or by both together.

Increased blood-pressure by itself may give rise to the most extreme degree of varicosity, as seen in cases in which the inferior vena cava has been obstructed, and the front and sides of the abdomen are covered with tortuous masses of dilated veins, studded with pouches in all directions. More frequently, however, although it helps, as in pregnancy, heart disease, &c., it is only one of the exciting causes, and perhaps not the most important.

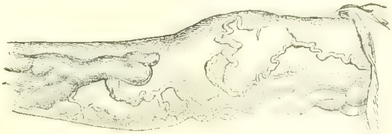


Fig. 41.—Varicose veins.

Diminished power of resistance is produced in various ways. Occasionally a vein becomes (and remains) varicose after some strain. In other instances the wall is weakened by inflammation, or suddenly loses some support to which it has been accustomed. Sometimes, as varicose veins are distinctly hereditary, there may be a congenital defect of structure, but probably in the great majority of instances the deficiency is really due to the feeble development of the muscular coat, and to its being easily tired out. Varicose veins are especially common in those in whom the circulation is weak and the vascular tone defective. Long-standing obstruction, or any other cause that entails upon the muscular coat an unusual degree of strain for an unusual length of time, leads either to hypertrophy (as in a simple case of obstruction of the vena cava); or, if the nutrition is feeble, to dilatation with thinning in some parts, and fibrous thickening (so that the walls become firm and inelastic) in others.

Varicose veins are rarely met with in children; after puberty they become more common up to middle life, and then again the tendency diminishes. In spite of the effects of pregnancy, men are said to be more liable to them than women, and those especially whose occupations entail long standing or very great and sudden muscular exertion.

The internal saphena vein suffers with exceptional frequency, from its length, the effects of gravity, the small amount of support it receives, as it lies outside the deep fascia, and the amount of blood discharged into it from the deep muscular and inter-muscular veins. The narrowing of the saphenous opening is probably of no importance. Sometimes the whole length is involved, more often only parts of it here and there, the intermediate portions being altogether normal; or the main trunk may be intact and the branches varicose, or only the minute tributaries, the venules in the skin, dilated. The deep veins of the leg (but not those of the thigh), are often affected to a greater extent than the superficial ones, and the disease may commence in them; very often it shows itself first where the two sets of branches communicate with each other. The external saphena suffers almost as often, and not unfrequently the whole of the foot or ankle is covered with a network of tortuous dilated vessels, running apparently indiscriminately. In other parts of the body (except in connection with the testes, labia, and rectum) varicose veins are rarely seen unless there is obstruction of one of the great trunks.

Varicose veins are not only dilated, but lengthened and thrown into loops and curves. In some places the walls are immensely thickened by the fresh development of fibrous tissue, so that when the vessels are cut across they remain gaping widely open with little or no tendency to contract. In other parts they are thinned and stretched, and so twisted up together that they form an ill-defined spongy swelling resembling cavernous tissue. The valves have often disappeared altogether or are reduced to shreds, which have no power of preventing regurgitation or supporting the column of blood. The skin is sometimes thickened, but more frequently it grows thinner and thinner until the vein almost protrudes through it, and even the bones beneath may be grooved and cut into deep channels by the persistent pressure.

Symptoms.—Varicose veins, so long as the circulation and nutrition are good, give rise to very little inconvenience, merely a sense of aching or of weight after exercise. Occasionally, possibly because a nerve is pressed upon, there is more acute pain, and it is believed that deep-seated muscular varices are sometimes the cause of painful cramps. The diagnosis rarely presents any difficulty, the colour, shape, distribution, and the difference in tension according to position are sufficiently characteristic. There may be a distinct impulse in coughing, especially when the upper part of the internal saphena is dilated, and it is said that this condition may simulate femoral hernia.

If, however, from any cause—age, ill-health, over-exertion, fatigue, &c.—the circulation begins to flag, the dilatation, the enormous weight of the column of blood, greatly increased in diameter and unbroken by valves, and the loss of vascular tone, soon produce, or help to produce, much more serious effects.

Chronic congestion, with œdema and more or less thickening and hypertrophy of the connective tissue of the part, is the first thing to happen. The red blood-corpuscles escape through the walls and cause deep pigmentation. The general nutrition of the tissues fails, chronic ulcers form, trivial injuries are not repaired, but leave behind them persisting sores; the skin becomes irritated and eczematous, and at last—not so much because of the varicose veins themselves as because of the general failure of the circulation of which they are but one of the signs—the whole limb becomes more or less affected.

Thrombosis is an exceedingly common complication, the blood coagulating in one of the outlying parts; sometimes the clot is absorbed, more frequently it becomes organised or undergoes degeneration. Phleboliths produced in this way can nearly always be found in the prostatic plexus. Occasionally the skin over the vein gives way, and very serious hæmorrhage results.

Treatment.—1. *Palliative.* All obstruction must be removed as far as possible. Tight garters are exceedingly injurious. In pregnancy the patient must rest as much as possible, or as is consistent with health, and wear a bandage or a stocking both during and for some time afterwards. The bowels must be kept well open, and long standing and excessive walking avoided, although a reasonable amount of exercise, stopping short of fatigue, is decidedly beneficial.

If the varix has made its appearance suddenly after exertion, the walls of the vein must be carefully protected from strain for some considerable time. The limb should be kept at rest, in the horizontal position, for two or three weeks, according to the size of the vein, and then carefully supported.

In the majority of cases all that can be done is to caution the patient against the evil effects of standing, &c.; maintain the general health by means of tonics, combined with good food, fresh air, and a fair amount of exercise, and supply some kind of support. Silk anklets, elastic stockings, and the appliances generally in use, serve the purpose for which they are ntended very ill: they produce the maximum of constriction when first applied, and then each week relax more and more until replaced; they are usually much too tight, and generally cause considerable wasting of the muscles. If worn once the limb becomes so used to their pressure that the patient can hardly be induced to leave them off. Bandages of thin flannel, lomet, or perforated rubber, are much better, as they can be put on with ust sufficient pressure and no more, instead of an iron rule being followed n all cases alike.

Upward friction and massage should be practised every night when the ppliance is removed. If bleeding threatens, the part should be well bandaged and kept at rest; if it breaks out (the usual situation is the lower hird of the leg) the limb must be raised at once. The hæmorrhage is xceedingly profuse, but it comes from the proximal or cardiac end, and aising the limb stops it instantaneously. If inflammation sets in and the eins become hard and painful, showing that they are filled with clots, the atient should be confined to bed, the limb placed in a slanting position n a leg-rest, and covered with lead lotion.

2. *Radical.*—In a certain number of cases the radical cure may be tried. s a rule it is only advisable where the superficial veins are concerned, and here the part involved is limited in extent. Sometimes, however, it is

beneficial in cases of varicose ulcer, in which the persistence of the sore appears to be dependent upon the vein. I have known an ulcer heal while the patient was in bed recovering from the operation, and remain sound for fifteen years afterwards, although previously it was always relapsing.

The choice lies between acupressure (with or without subcutaneous division), ligature and excision.

(*a*) *Acupressure.*—This is performed by passing a flat needle beneath the vein, while it is pinched up with the finger and thumb, and then twisting a figure-of-eight suture over the ends, protecting the skin beneath by means of a piece of bougie or quill. The needles should be about three-quarters of an inch apart, and the vein may be divided subcutaneously with a tenotomy-knife between them. They should not be left in for more than a week, and if any inflammation occurs this time should be shortened. Failure is not infrequent and there is always the risk of transfixing the vein.

(*b*) *Ligature.*—A small incision is made over the vessel, an aneurysm-needle passed round it and threaded with catgut. The ligature left when the needle is withdrawn is tied and the ends cut short. This method may be combined with the former, ligatures being placed in the intervals between the pins.

(*c*) *Excision.*—This is by far the most effective method, but it is only suited to a very limited number of cases. The skin is reflected from off the vein, the incision being as far as possible longitudinal; the vessel is carefully isolated from the surrounding tissue, a double ligature (catgut) is placed round it at each end and round each branch, and the whole intervening portion excised. Where any great length of vein is involved this is, of course, impossible, but the comparatively isolated bunches of veins that are frequently met with on the inner side of the lower third of the thigh can often be treated very satisfactorily.

THROMBOSIS

A thrombus is a clot that develops inside the heart or one of the vessels during life. It is distinguished from a post-mortem coagulum by the fact that it is drier, harder, less elastic, and distinctly adherent to the interior.

Red thrombi are formed in stagnant blood, white ones in that which is still circulating. The former are uniform all through, the latter are built up in strata, some of which are more coloured than others. Very often the two occur side by side, a white one forming first and gradually blocking up the passage until suddenly coagulation becomes complete.

Causes.—Thrombosis is due either to some alteration in the wall of the vessel, to some change in the blood, or to both causes together. It occurs chiefly in those parts in which the circulation is most feeble, beginning, for example, in the dilatations of varicose veins, or behind valves; where, on the other hand, the stream is rapid and forcible, as in the central part of an aneurysm, it may be delayed for a great length of time.

(*a*) The least change in the condition of the lining membrane is sufficient, whether due to injury, inflammation, or degeneration. The blood-plates are deposited at once upon any surface that is not perfectly healthy, and then the fibrin begins to collect. Foreign bodies introduced into the blood-stream naturally cause this at once. Stagnation very probably acts in the same way.

n typhoid, advanced phthisis, and other exhausting diseases it is not uncommon for clots to form quietly, without any injury or inflammation, in the eins of the lower extremities. These apparently commence behind the alves, in the layer of blood that under such conditions remains stagnant here, the endothelium of the lining membrane losing its vitality for want f a fresh supply, and causing the blood in contact with it to coagulate. Very possibly, however, in these conditions the composition of the blood is ltered too.

(*b*) It is an undoubted fact that certain conditions of the blood greatly avour coagulation, and also that certain substances introduced into the blood including the fluids squeezed from some of the organs of the body) cause eneral intravascular clotting, but the extent to which this takes place in isease is quite unknown. In various forms of septic poisoning distant thrombosis is not uncommon, possibly owing to the destruction of blood-plates or olourless corpuscles, especially as there is usually at the same time failure n the force and vigour of the circulation ; but the subject requires further nvestigation.

Thrombosis in arteries is rare except as a result of injury, inflammation, r atheroma ; in veins, on the other hand, it is exceedingly common, occurring both as a primary affection and secondary to injury or phlebitis ; in apillaries it can only occur when the wall of the vessel is gravely injured or ctually killed.

The changes that thrombi undergo vary according to their locality and ause.

Venous thrombi occasionally continue to spread towards the heart, until t length they meet with a vessel in which the current is too rapid. In this vay continuous clots of immense length may be formed, spreading through eins of larger and larger size, until at last the rounded end projects through side opening into the cavity of one of the largest. Here it may stop nd do no further harm, or it may be broken off and form an embolus, r, if the current fails in strength from any cause, it may reach the heart tself. This is especially likely to occur when they originate from poisoned vounds.

1. *Resolution* is not uncommon. Large masses of coagulated blood may nelt away and disappear within twenty-four hours, as is seen not unfreuently in the rapid cure of aneurysm by means of Esmarch's bandage. If ney last over this they are usually permanent. What becomes of the clot, ow it vanishes, is not known ; of course the channel is completely estored.

2. *Organisation.*— This takes place in the same way as in an artery : mph pours out from all the minute vessels around, and gradually replaces ne clot. Whether the endothelial cells or the white corpuscles in the cirulating blood help or not, is uncertain. Then fresh vessels form : fibroblasts evelop along their course, and gradually the clot and the walls of the vein e welded together into a mass of fibrous tissue. In many cases the cavity obliterated ; sometimes, however, capillaries communicating with the men of the vessel above and below enlarge and form a direct connection gain ; or the clot shrinks to one side and leaves part of the channel free. At ny rate it is not unusual to find, after some long period, that a blocked vein ecomes pervious again, a few strands of fibrous tissue being left across the terior, or clinging to one side of it, showing the fate of the obstruction. In

the case of aneurysms in which there is often an enormous thickness of laminated clot, organisation is a very slow proceeding, accompanied by shrinking and fatty degeneration.

3. *Degeneration.*—Large thrombi in the interior of a vein gradually become softer and softer in the centre, turning from red to yellow, and yellow to white, until they are filled with a fluid at first sight not unlike pus, but in reality consisting merely of caseating débris. The outer walls in contact with the still circulating blood usually form a firm casing; occasionally they break down, and then the liquid contents are poured into the blood-stream, causing minute embolisms, and the thrombus is said to be *canalised.*

Sometimes, especially in the case of the small thrombi forming behind the valves in veins, and in the prostatic plexus, calcareous degeneration occurs instead, and what are known as *phleboliths* are formed—small rounded and often pedunculated masses, enclosed in a fibrous sheath, and consisting mainly of phosphate of lime, with small quantities of sulphate of lime and of potash.

4. *Infective softening.*—If the micrococci of suppuration gain access to the clot, either through a local wound, through the wall of the vessel, or through the circulating blood, it becomes soft and breaks down into a fluid apparently of the same character, but in reality altogether different. Each fragment of the blood that enters into the current carries with it the germs of suppuration; wherever it becomes impacted, it cuts off the blood-supply, lowers the vitality of the tissues and renders them incapable of resisting the assault of the organisms it has brought with it; in other words, each embolus becomes the starting-point of a pyæmic abscess.

Consequences.—1. *Inflammation.* Every thrombus causes a certain degree of inflammation of the wall, so that if the vessel is superficial, the skin over it becomes red and tender and the soft cellular tissue around infiltrated with lymph. If the cause is not an infective one, this ends in organisation and repair, clearing up as the thrombus does; if, on the other hand, it is infective, suppurative arteritis or phlebitis follows, as the case may be.

2. *Obstruction.*—This differs very much according to the size and importance of the vessel. In the case of an artery the pulse ceases at once and the limb below becomes pale, numbed, and powerless; even gangrene may set in (the dry form) if the collateral circulation is not good. When a comparatively small vein is involved, there is little or no difficulty to the return of blood, owing to the free anastomosis in most parts of the body; but when it is an important one, such as the iliofemoral, and any length of it is obstructed, the consequences may be very serious. This is of common occurrence after parturition (phlegmasia alba dolens); the limb becomes tense, white, and painful, the vein can be felt as a hard knotted cord, and the weight is so great that the patient can hardly move the part. Sometimes this clears up within a very short time, the clot apparently melting away. More frequently recovery is only partial; the thrombus becomes organised and either shrinks to the wall of the vessel, or is perforated by small anastomotic veinlets, so that the channel is opened up again more or less completely. Occasionally it persists without yielding at all, and then, especially if the lymphatics are involved as well, a condition of what is known as solid œdema sets in, often ending in what is practically elephantiasis. The skin and the cellular tissue become enormously and irregularly thickened by the growth of fibrous tissue

the natural texture of the part is lost, and the weight may be so great that the patient is almost unable to lift it.

In cases in which the anastomotic circulation is more free, as when the inferior vena cava is obstructed by a thrombus, the collateral veins become hypertrophied, so that the skin over the front and sides of the abdomen is covered with great tortuous masses. At first, perhaps, this compensates, but when the obstructed vein is as important as the one mentioned, it rarely suffices for long, dilatation soon begins, the limbs become œdematous and swollen, the nutrition fails and chronic ulcers appear.

Finally, if spreading thrombosis occurs over a large area and involves the orifices of collateral branches, moist gangrene is very likely to ensue.

3. *Embolism* has been already mentioned as one of the remote consequences of thrombosis. It nearly always originates from venous thrombi and affects first the pulmonary circulation, but it may originate in the portal system. The consequences depend upon the size and the nature of the embolus.

EMBOLISM

Embolism is the impaction in some part of the blood-stream of a substance which from its size or nature cannot be driven farther; the substance itself is an embolus.

Emboli are derived from many different sources. A fragment of a thrombus is one of the most common. An end may be bodily torn off, especially if it projects through a side opening into the cavity of a larger vein; or the whole clot may undergo decay and disintegration, so that a mass of soft débris is discharged into the circulation at once. Vegetations are occasionally swept off from the cardiac valves, or calcareous or caseous fragments from an atheromatous ulcer. Malignant growths (especially carcinomata) sometimes perforate the walls of veins, and sprout into the interior. Abscesses, whether due to pyogenic or tubercular organisms, may do the same, the coats of the vessels gradually softening until the endothelium ruptures without any protecting thrombus having been formed. Liquid fat is often forced into the blood-stream in cases of fracture, and in exceptional instances many other substances, even parasites, find their way in.

Embolism may occur either in the systemic or the pulmonary arteries, or in the portal vein, the embolus originating, as a rule, in the venous system or the heart, and, of course, following the direction of the circulation. Wherever it originates, it is swept along until it meets with some vessel too small for it to pass through. Usually this corresponds to the point of bifurcation. Then, if it is liquid, it splits up into finer ones; if soft and yielding, like a recent clot, it moulds itself to the interior; and if hard and rigid it becomes fixed and completes the obstruction by causing coagulation around.

The immediate result is to stop the current through that branch. How this affects the area it supplies depends upon the size and nature of the embolus, and the perfection of the collateral circulation.

Instant death may, of course, ensue if one of the large branches of the pulmonary artery is blocked, or the middle cerebral. In other cases, however, every attempt is made to keep up the full supply of blood through the collateral branches.

a. If these are fairly abundant and healthy, so that dilatation is possible, no ill-result ensues; there is a temporary blanching of the part, the pulse fails below and it feels cold and numb, but this soon passes off and is followed by transient hyperæmia, in which all the vessels share. Later this general enlargement of the collateral supply gradually narrows itself down to one or two of the shortest and straightest routes, and everything is restored to its natural condition.

b. If, on the other hand, either dilatation is impossible, or—as for example in the case of the retina—there is no collateral circulation, the part gradually becomes starved out and dies. If it is in the interior of the body it undergoes fatty degeneration; if it is on one of the extremities, dry gangrene.

c. In certain organs (the lungs and kidneys in particular) what is known as infarction occurs. The collateral circulation is not sufficiently good to maintain the full blood-pressure, but yet is developed to a certain extent; the blood pours into the anæmic area (*e.g.* from the capsular vessels in the kidney), with sufficient strength to fill the capillaries, but not sufficient to maintain its course. As a result all the minute vessels become engorged, stasis sets in, the walls of the capillaries perish, the red blood-corpuscles pass through and fill all the interstices, and practically, at length, the whole area is absolutely solid with blood, forming what is known as a *hæmorrhagic infarct.* In the lungs this is seen in its most characteristic form, a conical mass of tissue, black and as hard as it can be; the base of the cone abutting in the pleura, the apex corresponding to the embolus, and the size depending upon that of the blocked vessel. In the case of an ordinary non-infective embolus this slowly undergoes fatty degeneration, a zone of hyperæmia forming round it, and the lymph-corpuscles invading it from the exterior, and quietly absorbing it until nothing but a depressed cicatrix is left.

The effect of an embolus, however, depends not only upon its size and the arrangement of the blood-vessels, but upon its nature. So long as it is absolutely unirritating (the fragment, for example, of a simple thrombus), the inflammation it excites is merely sufficient to cause organisation of the clot that forms round it, and seal it to the side. In ulcerative endocarditis, however, the vegetations that are detached from the valves are often so irritating that the walls of the arteries in which they are impacted become soft and yield before the blood-pressure, so that an aneurysm is formed. And in suppurative phlebitis, when pyogenic micro-organisms have gained access to the interior of the clot, and have caused it to break down into a puriform infective fluid, the consequences are more serious still. Wherever the débris is carried, it brings with it infective germs, which find in the engorged and lifeless mass of tissue the soil that suits them best; as a result the whole affected area melts away at once into the most intensely infective pus, and a true pyæmic abscess is developed.

Inflammation of Veins

Inflammation of veins may begin either in the tissues round (periphlebitis) or in the interior from the endothelial surface. It is nearly always acute; the chronic form, corresponding to the atheromatous degeneration of arteries, is seldom met with except in the thick-walled dilatations of varicose veins, and owing to the difference in the blood-pressure, does not possess the same degree of significance.

1. *Simple Acute Phlebitis*

This is due either to injury (ligature, contusion, &c.), the presence of a thrombus, or to some morbid condition of the blood, of which gout, rheumatism and syphilis are the best known. If a thrombus is not already present, one is formed as soon as the inflammation begins to affect the endothelial lining.

The changes that take place are those already described in thrombosis; the wall of the vein becomes thickened, softened, and more vascular, a greater amount of lymph is poured out, the endothelium changes in appearance, though whether it takes an active share in the production of the exudation is not known, and the thrombus itself, the coats of the vein, and the tissues around it are infiltrated with masses of lymph-corpuscles. The effect is the same whether the thrombus is primary and the cause of the inflammation, or whether it is secondary, the attack beginning from the outside as periphlebitis.

As soon as the irritation subsides the lymph is in part absorbed and in part converted into fibrous tissue. The thrombus, as already described, may either be absorbed, undergo organisation, or decay in the centre and ultimately be canalised. Sometimes the cavity of the vein is restored completely, more frequently it is obliterated for a time, and then subsequently, as the clot is organised or canalised, regains its normal shape and size to a greater or less extent.

Symptoms.—When the vein is superficial it can be felt as a hard, knotted cord, standing out under the skin and surrounded by inflamed cellular tissue. It is exceedingly tender to the touch, but, unless the periphlebitis is very acute, and the vein quite under the surface (as in the case of a varicose internal saphena) the skin is seldom much reddened. There is often a very considerable degree of pain and stiffness, especially on movement, or when the limb is allowed to hang down; and sometimes there is very considerable constitutional disturbance. In the case of the deeper veins the diagnosis chiefly rests upon the deep-seated hardness and tenderness, the peculiarly clumsy appearance of the part, the sense of weight and pain when the limb is allowed to hang down, the relief as soon as it is raised, and the evident distension of the more superficial vessels. Generally a certain amount of superficial œdema can be detected on the distal side of the obstruction, round the malleoli, for example, in cases of phlebitis of the deep veins of the leg.

Gouty, rheumatic, and syphilitic phlebitis can only be distinguished by the other symptoms that accompany these disorders; they have no certain distinctive character of their own, although the gouty variety is occasionally metastatic. They all have a decided tendency to symmetry, they affect the superficial veins rather than the deep ones, and the lower limbs much more frequently than the upper. Recurrence is exceedingly common in the gouty variety, and may continue in the syphilitic form all through the secondary period, but it is seldom that permanent obliteration is caused by either.

Treatment.—Rest is absolutely essential until at least all trace of inflammation and tenderness has disappeared. Serious extension of the thrombus and detachment of outlying fragments, causing embolism, are rare accidents, considering the very large number of cases of phlebitis of varicose veins of the leg, but they do happen occasionally, and every precaution must be taken to avoid them.

Elevation is no less essential for the sake of the return circulation and to relieve tension. Cold lead lotion, as a rule, causes the inflammation to subside within a few days; but in cases of gout, and where the arteries are atheromatous, belladonna (equal parts of the extract and glycerine) and warmth should be used instead. The bowels should be kept well open; the diet should be light, without stimulants, and if there is any evidence of gout, rheumatism, or syphilis, appropriate remedies should be employed.

Afterwards, when all the inflammation has subsided, the patient may be allowed to get about with a support, and if the leg is much wasted, or has a tendency to remain cold and œdematous, massage may be used to improve the circulation.

2. *Suppurative Phlebitis*

This, too, may originate either as a periphlebitis or in the interior. Examples of the former are often seen in diffuse inflammation of the cellular tissue; the pyogenic organisms rapidly destroy the coats of the veins, spreading along the loose cellular tissue round them, and causing them to slough or melt away into the purulent fluid that fills up every interstice. As the endothelium is approached coagulation takes place, and although the thrombus shares the fate of all the rest of the structures, fortunately, in the vast majority of cases, it extends sufficiently far and sufficiently rapidly to act as a barrier and prevent the poison spreading far and wide in the circulation. If it fails, or if it is broken down, general pyæmia is almost certain. This is of common occurrence in acute suppurative osteomyelitis, and in otitis media, infective inflammation with thrombosis spreading along the coats of the veins into larger and larger trunks, until at length the puriform clot that fills the vessel gives way, and is scattered all over the body, causing metastatic abscesses wherever it comes.

Acute spreading phlebitis of the same character, and ending in embolic pyæmia in the same way, may begin in the interior of a vein as well as round it. This, of course, unless pyæmia has already developed, can only take place after the cavity of the vein has been opened. Usually, under these circumstances the vessel either collapses at once, or a coagulum forms and extends up to the next set of valves, or the next large branch. If, however, septic decomposition sets in before organisation has taken place, and lends its aid to the micrococci of suppuration, the clot melts away at once into an infective puriform fluid, and there is every chance of a widespread distribution of infective emboli all over the body, even before the rest of the tissues succumb, or the diffuse cellulitis assumes alarming proportions.

SECTION III.—ANEURYSM

An aneurysm is a circumscribed tumour developed in connection with the interior of an artery and containing either fluid or coagulated blood.

Aneurysms have been classified in various ways : by their cause (traumatic and idiopathic or spontaneous) ; by their shape (fusiform, sacculated, and dissecting) ; and by the share the wall of the vessel takes in their construction (true and false). Some of these distinctions are very important.

All aneurysms are in a certain sense of the term traumatic, due either to one single sudden strain or to the continued effect of slighter ones ; but the term *traumatic aneurysm* is reserved for those cases in which a perfectly healthy artery has been injured in some accident, and either the wall, or the cicatrix, or the coagulum that closed the wound, has expanded into a sac. There is a very great difference in the matter of prognosis and treatment between this variety and the so-called *idiopathic or spontaneous* one, in great measure if not entirely the result of disease.

The terms *sacculated* and *fusiform* almost explain themselves, the former is applied to those cases in which a pouch is developed from one side of an artery ; the latter to those in which the whole circumference of the artery is stretched more or less. As, for example, in aneurysms of the arch of the aorta, no distinct line can be drawn between the two, or between the latter and what is known as aneurysmal dilatation. *Dissecting aneurysm*, on the other hand, is a very distinct variety ; it can only occur in the larger arteries and results from an early rupture of an atheromatous abscess in the wall. If this occurs before the coats are welded together by inflammatory exudation, the blood may make its way down between the layers of the wall for long distances, and ultimately break either into the interior again, or outside. In the former case it may give rise for a short distance to the appearance of a double aorta.

Aneurysms used to be described as true, when all the coats of the artery were to be traced in the wall, or according to others, when one of them could be. This, of course, is only possible when the aneurysm is fusiform in hape or exceedingly small in size, and the distinction is not worth maintaining.

An aneurysm sometimes ruptures, suddenly or gradually, producing the ame effect as if the artery had given way—an arterial hæmatoma. A diffuse neurysm is a contradiction.

IDIOPATHIC OR SPONTANEOUS ANEURYSM

Idiopathic aneurysm is due to the yielding of a weakened part of a vessel nder the influence of the blood-pressure.

Causes.—(*a*) All forms of inflammation predispose to aneurysm by the way n which they weaken the wall of the vessel. *Atheroma* is the most common, specially in its earlier stages, when the muscular coat is infiltrated with ymph and weakened, without as yet any considerable degree of degeneration. at a later period the floor of one of the ulcers yields and gives way, the adventitia is usually sufficiently thickened by that time, to render it secure. Dissecting aneurysm must of course be due to atheroma. *Embolism* is not infrequent, especially in young subjects, not because of the obstruction it causes (for then aneurysm would frequently follow ligature) but owing to the softening and inflammation of the vessel at the injured spot. In other cases it is a form of *peri-arteritis*, either syphilitic, as in the vessels at the base of the brain, or suppurative, when, for example, small aneurysms form on branches of the pulmonary artery in the wall of phthisical cavities.

(*b*) Injury acts both as a predisposing and an exciting cause. Its effects are best seen in the case of the popliteal, the inner and middle coats of which, even when it is healthy, may be ruptured by over-extension of the knee. Probably one reason why aneurysms are so common in this artery is that even when this does not take place, the walls are easily injured in the constant and violent flexion and extension to which they are subjected. In a few instances an aneurysm has developed in an artery that has been subjected to long-continued compression.

(*c*) The immediate cause is the blood-pressure. If the coats of an artery are weakened by injury or inflammation, they gradually yield before it, especially if it is raised by hypertrophy of the left ventricle, Bright's disease, chronic alcoholism, plethora or other causes. In many instances the first commencement of an aneurysm is traced to some sudden exertion, which either, as in the popliteal, directly ruptures one or more of the coats of the vessel by over-extension, or produces practically the same result by the immense increase in the blood-pressure that attends sudden and violent muscular efforts.

This serves to explain why aneurysms are so much more common in men than in women (with the exception of those of the carotid, which are equally frequent in both), and particularly among those who are exposed to sudden strains. Further it gives a satisfactory reason for the extreme frequency with which the popliteal artery and the arch of the aorta suffer in comparison with others.

Aneurysms are most common between thirty and fifty years of age, when the arteries are diseased, and the heart and the muscular system have not lost their vigour. Soldiers and sailors are especially liable to them, partly from their occupation, partly, perhaps, because of syphilis, although the share that this takes in the development of aneurysm is probably not a large one.

Mode of formation.—Fusiform and dissecting aneurysms are only met with in connection with the largest arteries. The former are caused by a uniform expansion of all the coats, so that the cavity of the vessel is increased in diameter and somewhat lengthened. The outer coat usually becomes thickened and strengthened by the addition of fibrous tissue formed from the lymph that is poured out in its interstices; the inner may be unaltered, although it is usually in a more or less advanced stage of atheroma; while the middle always degenerates, the muscular fibres becoming farther and farther separated from each other and ultimately disappearing altogether. Dissecting aneurysm, which singularly enough is more common in women than in men, is rare at all times, and is only met with in the aorta.

Sacculated aneurysm may arise by itself from the side of a vessel, or as a further development from a weakened spot in the wall of a fusiform one. So long as it is small, the adventitia, thickened and more densely fibrous than elsewhere, can be traced over it, and it may appear to be still lined with intima: but even in small ones the middle coat is wanting, and in those of moderate size, and still more in large ones, no distinction of coats can be made out in any part. The sac-wall is formed of fibrous tissue, partly the product of inflammation excited by the constant pressure, partly the residue of the structures which it has displaced, turned on one side, and caused to atrophy. Even bone and cartilage waste away before an aneurysm, but as they resist longer than most other structures, portions of them are occasionally found in the wall, projecting into the sac. The lining membrane may be smooth and shining, or covered with calcareous plates and irregular from atheroma, but it cannot be separated from the fibrous wall.

Fusiform aneurysms rarely contain any clot, or at the most a small thrombus formed upon a projecting calcareous plate. Sacculated ones, on the other hand, are seldom quite empty and may be completely filled. It varies in character and appearance according to its age, and whether it has been formed from stagnant or circulating blood. The oldest part, that which lines the sac-wall, is hard, dense, and yellowish-white ; inside this are generally many layers, more or less coherent, some coloured and others not, but less firm ; and inside these again very often a loose, soft, and recent coagulum. No sharp distinction can be drawn between them, although the extremes are exceedingly different. The one is known as *laminated* or *active* clot, containing very few red corpuscles. As the blood whirls round in the interior the platelets are whipped out from it and deposited upon the irregularities of the surface until they are welded together into a coherent mass by the fibrin that they form. This is repeated again and again, and layer after layer is thrown down, some quite colourless, others, when the circulation is slower, containing a few red corpuscles, until in successful cases the whole interior is filled. Even when this does not happen the wall is rendered immensely stronger wherever the layers are formed, and as the size of the cavity diminishes the expansive power of the blood-pressure diminishes too.

The loose red coagulum formed from stagnant blood is called in distinction *passive*. Its behaviour is always very uncertain ; sometimes it melts away and disappears, so that an aneurysm that felt quite solid one day may the next pulsate as strongly as ever ; sometimes, on the other hand, it shrinks and becomes organised, or under the impact of the blood-stream is flattened out into a coloured lamina. It is not, therefore, so useless as its name implies. The future destiny of the laminated clot cannot be regarded as certain. The white corpuscles it contains undergo fatty degeneration and the longer it lasts the thinner and harder it becomes, until at length in old cases it disappears altogether, probably undergoing fatty transformation and absorption. There is no proof that it becomes organised, its density is too great.

Sacculated aneurysms may attain an enormous size ; not unfrequently more than one is present, and in any case the heart and every artery in the body that is accessible should be carefully examined before the treatment is determined.

Symptoms.—The first appearance of an aneurysm is a soft, elastic, circumscribed and pulsating swelling in the course of one of the large arteries. Its features vary according to the amount of clot it contains. At first it is filled with fluid blood, but by degrees, as fibrin is deposited, it becomes firmer and harder, until at length in some cases it is absolutely solid, and presents all the characters of a solid growth. The pulsation varies in the same way. So long as the contents are fluid and the cavity communicates directly with an artery, this is characteristic ; the sac becomes tense with each beat of the heart and expands in all directions ; it is not merely the lifting up and falling down of the mass, as when a solid growth rests upon the wall of a vessel, it is an *expansile pulsation*, and this peculiarity can usually be recognised at once by placing the fingers one on either side of it, or one above and the other below. As, however, it becomes solid this is lost. At first there may be some pulsation communicated to the tumour from its resting upon the artery; but even this, when the vessel is thrombosed, disappears, and it remains perfectly motionless.

The difference in the tension, which is no less marked a feature, depends upon the same cause. If the limb is raised, the artery contracts, and so long as the contents are fluid the pulsation and the tension in the sac diminish ; if it is allowed to hang down, the effect is just the reverse. If the artery is compressed upon the cardiac side the pulsation ceases, the tumour shrinks in size and may even become perfectly empty and collapse. When the finger is raised, it fills again in two or three beats, expanding forcibly in all directions.

In nearly all cases, so long as the blood circulates through the cavity, a bruit is heard all over the tumour, synchronous with the beat of the heart, and very often a thrill is felt. These, of course, vary very greatly, not only in different cases, but at different times in the same, as they depend upon the position of the orifice, and the amount and situation of the laminated clot deposited inside. Care must be taken in investigating this not to compress the artery against a subjacent bone, as a distinct bruit can be caused in this way even when the vessel is perfectly healthy.

In internal aneurysm, on the other hand, or where the tumour is inaccessible, these signs may be wanting altogether, and then the diagnosis must be made partly from the effect upon the pulse, partly from the pressure symptoms.

The pulse in the parts below is always modified, the force of the heart is lost in stretching the sac, and little or none of this is returned, owing to the absence of elastic recoil. If the aneurysm is a large one, especially if it is near the centre of the circulation, compensative hypertrophy of the left ventricle sets in ; if it is farther away the collateral circulation enlarges, but in any case the pulse below is wanting in strength, the sphygmographic tracing shows the wave is lower and less marked, and the tissues beyond are ill supplied with blood. In some instances the wasting and loss of strength produced in this way are very characteristic.

An aneurysm, by its immense and constantly varying pressure, always causes a certain degree of inflammation in the tissues around. In most cases this is merely sufficient to develop the fibrous capsule, but sometimes, especially in the axilla and the groin, where the enlargement is very rapid, suppuration sets in and the whole sac sloughs out. In addition it often gives rise to very important signs by the way in which it interferes with the structures near it. Bones are absorbed, being hollowed out or perforated, as in the case of the sternum, without of necessity a trace of inflammation; cartilages are treated in the same way, although they resist longer ; muscles become reduced to flattened fibrous bands ; veins are obliterated ; nerves stretched and expanded into ribands, and in certain situations other organs, such as the œsophagus, trachea, or thoracic duct, compressed and prevented from working. The symptoms caused in this way are naturally of the most varied character. Intense neuralgic pain, referred to the distribution of the nerves and worse at night, is one of the most common; spasmodic contraction, paralysis, wasting, hyperæsthesia, and alteration in the electric reaction may occur. The sympathetic in the neck may be pressed upon, causing vaso-motor and pupillary changes. The recurrent laryngeal may be paralysed, giving rise to a peculiar and most significant tone of cough. There may be the most intense pain from pressure upon the cords of the brachial plexus. In short there is scarcely a symptom due to nerve irritation or compression that does not occur sometimes in connection with aneurysm. Immense congestion, with dilatation of the veins, œdema, and even moist gangrene, may be caused by pressure upon one of the great venous trunks. Dyspnœa and dysphagia may occur from partial occlusion of the trachea or œsophagus. And even in some very rare cases, the artery itself may be so compressed by the aneurysm springing from it, as to cut off the circulation through it, and so effect a permanent cure.

Progress and termination.—Aneurysms, especially fusiform ones that partake rather of the character of aneurysmal dilatation, and those which occur in old people who lead quiet lives, occasionally last for many years unchanged. This, however, is exceptional; as a rule, if left to themselves they either undergo spontaneous cure or prove fatal from rupture of the sac, suppuration, pressure upon some important organ, or, especially in the case of large thoracic ones, syncope.

1. *Spontaneous* cure may be produced in various ways.

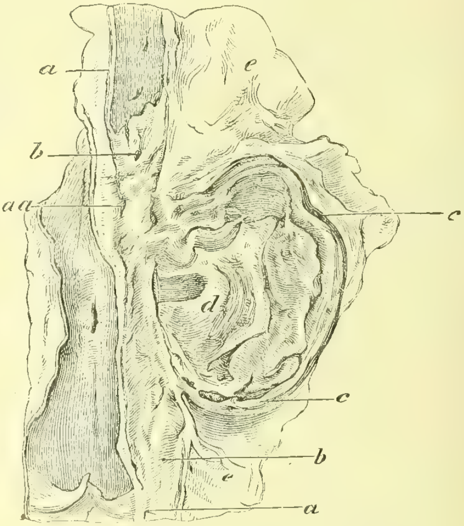
(*a*) The sac may gradually be filled with laminated clot, until at length the artery itself is occluded, or there is merely a narrow channel left, running down through the centre of the tumour. A certain amount of active clot is present in all cases of sacculated aneurysm, forming as it were in the eddies of the blood-stream; if this is diverted from time to time into different directions, so as to fill up one part after another, or if the circulation through it is rendered very slow and uniform by some accident, such as the development of the collateral circulation, the pressure of the aneurysm upon the artery above, or the formation of a fresh aneurysm upon the same trunk higher up, it sometimes happens that the whole sac is obliterated and cure effected (fig. 42).

When this occurs the tumour becomes smaller and harder, the characteristic expansile pulsation ceases, although, so long as the artery is unobliterated it may be lifted up and down with each beat, and the bruit and thrill disappear. At the same time the collateral vessels can sometimes be detected; and not unfrequently their enlargement is attended with a certain amount of aching pain. Finally the whole sac shrinks to a small, hard nodule, sessile upon the artery.

(*b*) The distal orifice of the sac may be suddenly plugged by a detached fragment of clot. In this case the aneurysm rapidly becomes filled with stagnant blood which coagulates, forming a loose soft clot, and then gradually shrinks under the pressure exerted upon it by the displaced tissues around. If the coagulum extends into the orifice of the artery, the cure is likely to be permanent, organisation taking place in that part of the recent clot which is in contact with the intima of the vessel, the rest being ultimately absorbed.

Rapid cure of this kind is usually attended with a severe degree of pain for a short time, the limb feeling exceedingly tense and full, and the part beyond cold and numbed. Ultimately the collateral circulation enlarges and the sac shrinks up as before.

(*c*) Suppuration may occur. The loose cellular tissue round the sac becomes more and more inflamed, the outline of the tumour disappears; the skin over it becomes hot, red, and œdematous, the size of the part increases rapidly; there is intense throbbing pain with high fever, and then suddenly the skin gives way over it, and pus mixed with sloughing shreds of fibrin, chocolate-coloured masses of the broken-down blood-clot, and perhaps fresh arterial blood pours out. Suppuration has taken place round the aneurysm and it has sloughed. If the walls of the artery above and below have been able to resist the action of the pyogenic micrococci, and form and organise a thrombus in their interior, hæmorrhage may never occur, and the cure may be permanent; if, on the other hand, as too frequently happens under these circumstances, the nutrition of the tissues fails, organisation lags behind, the clot softens and melts away under the influence of the blood-pressure, and the gush of arterial blood may prove instantaneously fatal.



a. The cut edge of the arterial coats where healthy.

a, a. The coats in the diseased and occluded part of the artery. Their substance is dispersed and blended with the new fibrous tissue, *b*, which fills the vessel, yet not so much diffused but that they can still be traced to the mouth of the aneurysm (opposite the upper *c*).

c. The aneurysm sac, composed of laminated clot and compressed tissue welded together indefinitely.

d. Scarcely laminated clot, filling the hollow of the sac.

The vein, with two valves in its lower part, is seen close behind the artery.

FIG. 42.—Section through an aneurysm of the popliteal artery, cured nearly two years before by digital pressure. The aneurysm is not dissected out, but left embedded in the popliteal fat, *e*, *e*. The artery is occluded with the aneurysm.

2. *Enlargement.*—The pressure in the interior of an aneurysm increases in proportion to its cubic contents. Partly for this reason, partly perhaps because after a certain time the tissues round it resist less well, it is not uncommon to find after it has reached a certain size that the rate of growth becomes much more rapid and the wall exceedingly thin. In these circumstances, if it does not prove fatal from syncope, suppuration, or pressure upon some organ essential to life, rupture occurs sooner or later.

The way in which this takes place and the symptoms to which it gives rise vary with the situation. Hæmorrhage into a serous sac is usually rapidly fatal, a great stellate opening forming and admitting a full rush of blood. When it occurs on a mucous surface, on the other hand, days may pass before the final outburst, the orifice being very minute and becoming plugged with a coagulum which only allows a certain amount of leakage from time to time. Rupture on the cutaneous surface is still more rare, unless preceded by inflammation and suppuration. The tumour may render the skin red, tense, and shining, or may even raise the epidermis up in the form of a blister, so that bloody serum soaks through and forms a scab on the surface; but unless suppuration occurs, or a slough is formed, external hæmorrhage is, comparatively speaking, a rare form of death. In the majority of cases of rupture the sac gives way subcutaneously, and the blood is extravasated into the cellular tissue. A small amount usually escapes at first, causing some increase in the size of the tumour, then it coagulates and forms a wall around itself. After this it may remain quiet for several days, or may cause suppuration, or may, in very exceptional instances, lead to the development of a new and stronger sac. More frequently it is only the prelude to a more extensive hæmorrhage which pours in all directions into the cellular tissue around, causing the most intense pain, and leading to complete cessation of the circulation in all the parts below. The patient may faint at once and become collapsed, partly from the loss of blood, partly from the shock and pain; the limb beyond becomes cold, œdematous, and pulseless; the region of the aneurysm is immensely distended; all bruit and pulsation disappear, and if speedy steps are not taken moist gangrene is inevitable. An aneurysm that is enlarging very rapidly, especially in one direction, is sometimes described as leaking; either the sac has already given way, or it is in imminent danger of doing so, and there is the greatest risk that actual rupture, which in an aneurysm of any size is hopeless so far as the limb is concerned, and always places life in very serious jeopardy, may occur at any moment.

In the case of ruptured popliteal aneurysm, the appearance of the limb is not unlike that produced by deep-seated suppuration; the skin all round the back of the joint is red, tense, and œdematous on pressure, the pain is most acute and throbbing, and the history may be that of a rapidly forming abscess; but the cessation of the circulation in the limb below, the coldness and œdema of the part, and the loss of sensibility in the toes, point unmistakably to some grave interruption in the blood-supply. Moist gangrene in such cases is inevitable.

Diagnosis.—1. In its earlier stages, while it still pulsates.

(*a*) Aneurysm may occasionally be confounded with a form of aneurysmal dilatation chiefly met with in the innominate and the abdominal aorta in young women. The dilatation and the pulsation are often exceedingly well-marked, but the age and sex, the effects of tonics, especially iron, and the evidence of other nerve troubles are usually sufficient to make the diagnosis certain at once. As the dilatation disappears again completely there can be no serious morbid lesion in the wall of the vessel.

(*b*) Fluid tumours, bursæ, hydatid and other cysts and chronic abscesses in the neighbourhood of large arteries or on their walls, occasionally present great difficulty. If, however, they pulsate they do not expand in the way that an aneurysm does, and though they contain fluid they cannot be even partially emptied by pressure upon them. A bruit or thrill is exceptional, though it may be produced if the artery is compressed or bent irregularly.

(*c*) Pulsating sarcomata are usually found in early life or in localities in which aneurysm is either very rare or practically unknown, and even when they do grow from such places as the back of the knee-joint the diagnosis is seldom difficult. The pulsation is not expansile; the bruit, when there is one, can only be heard over a limited area; the tumour cannot be emptied either by direct pressure or by compression of the artery above, and even if it can be reduced in size, it refills slowly, not with the rapid bound of an empty aneurysmal sac. In some instances, however, when the tumour is intrapelvic, a positive statement is often impossible without examining the case more than once and watching the manner of its growth.

2. Aneurysms that do not pulsate, whether this arises from their being already filled with laminated clot, or from some peculiar anatomical relation to the artery from which they spring, are exceedingly difficult. All the ordinary signs fail completely, there is no pulsation or bruit, the tumour cannot be emptied, it lies in the region of an artery, but it cannot be separated from it or lifted off it. In short, in all such a most guarded opinion must be given until the case has been watched some little time. If it is a cured aneurysm it will slowly tend to become smaller and smaller; if it is not cured, but merely prevented pulsating by some accidental condition, it will either cure itself or some day pulsation will suddenly make its appearance.

3. Ruptured and suppurating aneurysms can usually be recognised by the complete and sudden obstruction to the circulation in the part below. Even if no history can be obtained, the coldness of the distal portions, the œdema, numbness, and cessation of the pulse, should at once arouse suspicion. In any case of doubt the introduction of a grooved needle can do no harm, but both the patient and the operator must be prepared for any measure that is necessary. Suppuration may be distinguished from simple rupture by the intensity of the local signs of inflammation.

Treatment.—Aneurysms may be treated in many different ways, according to the conditions under which they are placed, but the idea is the same in all, to bring about one or other of those changes by which spontaneous cure is effected, viz., the deposit of laminated clot, the rapid coagulation of the contents of the sac, or the exclusion of the aneurysm from the circulation, as in suppuration.

I. *The deposit of laminated clot*

This may be accomplished either by increasing the amount of fibrin in the blood, or by rendering the circulation through the sac as slow and as uniform as possible. Of these two, the first is at present entirely beyond our power; nothing is known that can increase or diminish the amount of fibrin without at the same time causing even more serious changes, and it must be remembered that an increase in the quantity of fibrin is not the same thing as increasing the readiness to coagulate.

The circulation through the sac may be controlled by constitutional or local measures, or by both together.

(*a*) *Constitutional treatment.*—Rest, in the recumbent position, is of the utmost importance; it lessens the force of the heart-beat, reduces its frequency, and keeps it uniform. The sudden enlargement of an aneurysmal sac can often be traced directly to some comparatively trivial exertion.

The diet must be restricted. In many instances it is of advantage to adopt Tufnell's system. The patient is placed on a well-made hair mattress, with a water cushion, and forbidden to raise hand or foot for any reason. The diet is reduced to eight ounces of solids and six of fluids per diem (six ounces of bread with a little butter, two of meat, and six of milk), and is maintained at this level for some weeks. The patient of course becomes xtremely emaciated and feeble (it is necessary to take great care that he loes not catch cold), but the number of heart-beats can be reduced to forty-wo or forty-four in the minute ; and not unfrequently it happens while this s going on, that, owing to the slowness of the current in the aneurysm, many resh layers are deposited on its wall. Moreover, the improvement is not only maintained, but often becomes much more marked when the diet is gradually raised again. In patients who are feeble and anæmic already, this of course is not advisable. Not unfrequently with them a more generous liet, combined with iron, reduces the frequency of the heart-beat, although t may somewhat increase the force ; stimulants, however, should always be avoided.

The bowels must be kept well open ; if the arterial tension is high, repeated saline purges are recommended, and even venesection. Opium is of great use in controlling pain and procuring sleep. Other drugs are recommended from time to time, but it is difficult to show that any improvement that takes place during their administration is actually the result of their nfluence. Iodide of potash, for example, has a distinct effect upon the blood-pressure, and relieves the nocturnal bone-pain so common in some forms of nternal aneurysm, and moreover is sometimes of benefit when there is a decided history of syphilis ; but it certainly tends to diminish the coagulability of the blood. Digitalis may modify the action of the heart, but it also ends to raise the arterial pressure. Aconite and belladonna may be given with better reason. There is no proof that either ergot or acetate of lead has the least effect.

(*b*) *Local treatment.*—The simplest method is to raise the part if it is one of the limbs, bandage it, and apply gentle pressure over the tumour. This, however, is rarely enough, except in the case of the anterior tibial or other small vessels. Sometimes these are injured in fractures, and then an aneurysm may develop and be cured while the patient is lying in bed with his limb in splints. Whatever method is finally adopted, bandaging and elevation always form part.

1. *Compression of the main artery on the cardiac side.*—This may be igital or instrumental ; in either case the object is to diminish the stream f blood flowing through, so that the fibrin may be deposited on the walls. t is not necessary to occlude the artery completely, all that is required is o prevent pulsation in the sac ; and this is especially to be remembered, s many cases in which this plan has failed have been given up because he patient would no longer stand the pain, and in one or two inflammaon of the wall has been caused, and a second aneurysm has developed ater on.

The patient must be placed in a comfortable position, and the skin shaved nd powdered well with French chalk. Digital compression is to be prerred wherever it is possible, but it can only be carried out where the artery s superficial and rests against a bone, as in the case of the femoral at Pouart's ligament, and at least three people are required. Two fingers should e placed upon the vessel, care being taken not to include the vein, and a eight of about four pounds (suspended by a pulley from somewhere overead) allowed to come down and rest upon the dorsum of the last two phanges. Pressure, carried out simply by muscular exertion, is exceedingly hausting, and can only be kept up for a short time. With the aid of a eight it can be maintained with perfect uniformity for half an hour without changing and without fatigue. When a change is made, the vessel should be secured above or below with the other hand, so that no pulsation can take place in the aneurysm, and the grasp should not be relaxed until the new-comer is certain that he has secured the vessel. One hand should be kept upon the aneurysm the whole time, to make sure that there is no pulsation. The number of hours this treatment has to be maintained depends a great deal upon the thoroughness with which it is carried out. Usually compression is continuous for the first twelve or fifteen hours. If the tumour becomes solid in that time it is probably filled to some extent with laminated fibrin, but much more with recent soft coagulum, and the limb must be elevated and firmly bandaged with a compress over the whole length of the artery for twenty-four hours more, for fear of the contents being washed out again. At the end of that time it is fairly safe, although no precaution may be relaxed until the tumour has begun to diminish distinctly. If no change is detected, it should be left for a few days, and simply bandaged; perhaps at the end of that time a certain amount of fibrin will have been laid down and it is certainly better to allow the patient time to rest. Even when every precaution is taken continuous compression becomes very painful, especially if there are any enlarged glands round or near the vessel. At the end of a week a second attempt may be made, following the same plan, or shorter sittings may be tried for four or six hours a day, until the cure is complete. When this is successful, the fibrin is deposited in laminæ, but it may be a week before there is any distinct solidification. If it has been tried well and it does not succeed at the end of that time it should be given up.

Instrumental compression is carried out on the same plan, chiefly with Carte's tourniquet, which has the advantage over others of greater elasticity of pressure and of a double pad, so that the point of compression can be varied without moving the instrument. In some parts of the body (the abdominal aorta for example) only instrumental compression is possible; but in most, if it can be managed, the digital plan is to be preferred as less likely to injure the artery and more easy to adjust.

Opium is not unfrequently required to allay irritability and to procure sleep. Sometimes, as in the case of the abdominal aorta, an anæsthetic is necessary. If compression fails or the patient will stand it no longer, the artery must be tied, but not at the spot at which it has been compressed, for in all probability the coats of the vessel are somewhat thickened there, and perhaps matted together by adhesive inflammation. It appears from statistics that ligature after compression is not so favourable as immediate ligature—what this may be due to is not certain; there is no doubt that the collateral circulation enlarges from the effect of continued pressure and that this, while it checks the tendency to gangrene, at the same time maintains, perhaps too well, the current through the sac; but it must be remembered that the cases are not like fresh ones, they have already failed once.

Compression is the plan of widest and most general application; it avoids the necessity for a wound and the risk of secondary hæmorrhage, but it can only be employed in certain cases (fortunately the majority); it must never be used where from the presence of œdema or venous engorgement, there is reason to fear obstruction to or pressure upon the main vein of a limb, or where the sac is enlarging rapidly and in danger of rupture; and it must be admitted that sometimes, perhaps from want of intelligence on the part of the patient, it is exceedingly difficult to carry out thoroughly.

2. *Ligature of the artery on the cardiac side, at a distance from the aneurysm, the Hunterian operation.*—The object is to allow a slow stream of blood to flow through the sac and deposit layers of fibrin upon the walls, not to cut off the circulation completely, and fill the cavity with a loose, soft coagulum. Additional advantages of ligature at a distance from the sac over ligature close to it are that the operation is easier, the best part of the vessel being selected; that the artery is much more likely to be healthy; that the sac is less interfered with, so that there is less risk of suppuration; and that the collateral circulation is likely to be better, and the danger of gangrene less.

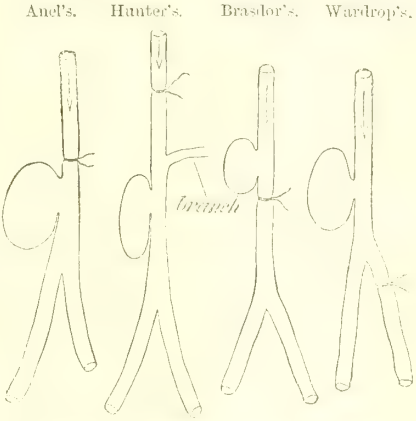


FIG. 43.—Diagram showing the different operations for aneurysm.

The immediate effect of tightening the ligature is to stop the pulsation in the aneurysm. The blood-pressure begins to fall at once; the tissues around resume their normal position; the tumour diminishes in size; and its outline becomes less distinct. In most cases, however, especially when compression has been tried before ligature, and the collateral circulation is already established, coagulation does not take place at once; the current is not shut off completely; from the first it flows through in a gentle continuous stream, and under its influence fibrin is deposited in layers on the wall until the sac is filled and the artery blocked above and below. In some cases slight but distinct pulsation can be detected, the stream is so strong; not, as a rule, for two or three days after the operation—not, that is to say, until the collateral vessels are thoroughly expanded; then growing more and more marked, and finally as the walls become thicker, fading away again. In a successful case the sac diminishes in size, until at the end of three or four weeks it is small, shrunken, and hard. The artery is obliterated at the seat of ligature, and again opposite the aneurysm; in between it not unfrequently remains pervious (fig. 44).

After the operation the patient should be placed in bed with the limb arranged in an easy position, wrapped in cotton-wool and slightly raised. It may be surrounded with hot-water bottles, but none should touch it. Ligature is liable to certain risks from which compression is more or less exempt.

(*a*) Secondary hæmorrhage may occur, or the ligature may give way, or soften prematurely, leaving an artery bruised and partially divided, exposed to the full effects of the blood-stream. Not unfrequently, in spite of careful selection, it is very difficult to make sure of finding a part of the artery that is absolutely healthy.

(*b*) Pulsation may return, either from some aberrant branch or because of the development of the collateral circulation. If this is only slight it need not excite alarm, but if it continues, and particularly if after lasting four or five days it becomes more marked, the prospect is not good. Sometimes, even then, if the limb is kept carefully bandaged it subsides of itself; but if it does not, as soon as the wound in the artery is sound, means must be taken to make the blood that is in the sac coagulate. Probably, if other things are suitable, Esmarch's bandage is the best; with such perfect development of the collateral vessels there can be little fear of gangrene; in other cases flexion, pressure on the artery between the aneurysm and the seat of ligature, or above the latter point, and possibly even ligature of the artery higher up; may be required. Amputation is the last resource if the sac continues to increase in size and threatens to give way.

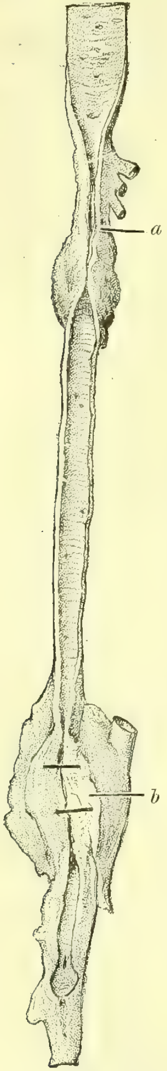


Fig. 44.—The Femoral and Popliteal Vessels, five years after ligature of the superficial femoral for the cure of a popliteal aneurysm. The vessel has been occluded by the ligature at *a*, and again at the seat o' aneurysm. The aneurysm itself is represented by a small mass of fibrous tissue, *b*. The artery between the ligature and the sac is patent.—(Bowlby.)

(*c*) Gangrene may occur. The aneurysm itself is no inconsiderable obstruction, although, if it has formed slowly, the collateral supply round it has usually had time to enlarge; the tissues beyond are frequently ill-nourished, the heart is often dilated rather than hypertrophied, and the vessels in many cases are atheromatous. Ligature of the main trunk under conditions such as these easily leads to gangrene; and if the vein is pressed upon or injured, or the sac has begun to leak, or there is any inflammatory œdema, is almost sure to do so. Usually it is of the moist variety and amputation is inevitable; sometimes, when it is dry and very slow in its course, a line of demarcation forms, and only a part of the limb is lost.

(*d*) Suppuration round the sac. This was not an uncommon occurrence when the artery was tied near the aneurysm, in a great measure owing to the extent of the manipulation. Sometimes, especially when the sac has rapidly enlarged, or has been much handled, it happens even when the operation is performed at a distance. If the sac has ceased pulsating it should be left as long as possible until the skin shows signs of giving way; with good fortune the ends of the artery may become sealed, and turning out all the clots would only increase the chance of hæmorrhage by opening them up again. If, however, pulsation continues, there is no hope but in amputation, plugging, or placing a tourniquet upon the artery higher up, laying the whole open from one end to the other, turning out all the sloughs and broken-down clot, and securing everything that bleeds as far from the surface of the wound as possible. Afterwards, and in any case, watch must be kept night and day until the wound is healed.

3. *Distal ligature after Wardrop's method.*—This is ordinarily classed with Brasdor's, and as a matter of history was a deduction from it, but there is an

essential difference between them. In Brasdor's the whole circulation is cut off, the aneurysm is left full of clot, and complete obliteration is aimed at. In Wardrop's the whole circulation is not cut off, large branches are left either between the seat of ligature and the aneurysm or arising from the sac itself; and these branches begin at once to increase in size, so that whatever benefit is derived from the operation, and in some instances it has been shown to be very considerable, it cannot be due to immediate obliteration of the cavity.

As a matter of practice it is reserved almost entirely for aneurysms at the root of the neck, whether springing from the subclavian, innominate, or aorta. The benefit some of those springing from the arch itself have derived is very remarkable, although in some of the earlier cases the operation was performed under the erroneous impression that the innominate was concerned. As at first practised, the carotid and subclavian were ligatured simultaneously with a view of diminishing the amount of blood flowing through; but that this cannot be the correct explanation is clear from the fact that in some cases as much benefit has been derived from ligature of the left carotid only. The result must be due either to a coagulum projecting back into the sac, and acting as a nucleus for the deposit of laminated fibrin, or to the fact that the direction of the stream is changed, and the pressure transferred to parts which not only have not been so much weakened, but which even may have been strengthened by the deposit of fibrin upon them while they were lying out of the direct flow. Possibly there is something to be said for both views.

II. *Rapid coagulation of the contents, such as is produced naturally when an embolus is dislodged and blocks the distal orifice*

The natural method of cure may be imitated in many ways, with varying success; but with the exception of one (the use of Esmarch's bandage) it is only employed under special conditions when ligature or compression is out of the question. Constitutional treatment must, of course, be maintained at the same time.

1. *Esmarch's bandage* (*Reid's method*).—The aneurysm is filled with blood, and the circulation arrested above and below.

An elastic bandage is applied to the distal part of the limb, either eginning at the end and carrying it up to the sac, or leaving the fingers or oes as the case may be and commencing only a short distance below. The ac is then allowed to fill; the bandage either carried over it very lightly, or nade to skip it altogether, and applied firmly again to the part above. If here is not sufficient room, an elastic strap may be used, or an abdominal ourniquet, as the case requires. The bandage is usually applied for about wo hours (I have known half an hour successful, but this was a very xceptional case) and then digital or instrumental compression kept up on he trunk above for twelve hours more, in order to protect the clot at the ntrance of the vessel from the impact of the blood.

In a successful case the whole of the sac is filled with a coagulum which xtends into the artery and occludes it. The hope is that this, if not dis-laced, will become organised where it is in contact with the intima, and be eplaced by fibrous tissue; while the rest of the coagulated blood, lying ut of the current, will either be absorbed or dry up. Possibly it may become

An anæsthetic is absolutely necessary the whole time, as the proceeding is very painful. If the aneurysm is on one of the limbs, this should be raised and carefully wrapped with cotton-wool before the constriction is removed.

The chief advantages of this method are its simplicity and rapidity. It succeeds best, naturally, with small aneurysms in young subjects free from cardiac disease or extensive atheroma, and should not be used for large ones or those on the point of rupture. At the same time, it is practically the only plan admissible for some aneurysms of the abdominal aorta and its branches.

Failure is not infrequent, the aneurysm appearing perfectly solid when the bandage is unwound, but becoming completely empty by the next day in spite of the precaution of pressure upon the supplying trunk. If this happens once, it is nearly sure to happen a second and a third time. If, on the other hand, the coagulum remains firm for twenty-four hours, the cure is likely to be permanent.

A considerable amount of ecchymosis is often noticed round the sac, but it does not appear that there is any unusual danger of gangrene. The bandage has been kept on for upwards of three hours and a half in a case of popliteal aneurysm without any ill effect. Rupture has occurred on one or two occasions from the tension to which the sac has been subjected; and there is always the possibility, if there is any cardiac disease or atheroma of neighbouring vessels, of throwing too great a strain upon them, but, provided the cases are carefully selected, it is as safe as any other method.

Where it is possible, the elastic strap tourniquet should be avoided, and two or three turns of a broad rubber bandage made round the part instead; the sharp constriction of a rubber band has before now caused paralysis of a nerve by compressing it against a subjacent bone.

The other methods for obtaining rapid coagulation are of very limited application.

2. *Manipulation.*—An attempt is made to detach some of the clot from the interior, and plug the distal orifice with the embolus, as in the natural method. The artery should be compressed upon the cardiac side during the manipulation. This has succeeded in a few instances in which there was practically no alternative; but it should never be tried at the root of the neck, if there is the least suspicion that the carotid is involved.

3. *Flexion.*—Aneurysms at the knee and elbow may be compressed, and the pulsation stopped by extreme flexion of the joint, but the process is painful, uncertain, and only advisable under special circumstances, when, for example, pulsation has returned after ligature. The limb must be bandaged as high as the aneurysm, flexed until pulsation ceases, and then fixed for some hours, the patient meanwhile being kept under the influence of morphia. Afterwards the same precaution must be adopted as in Reid's method.

4. *Brasdor's operation or distal ligature of trunk without leaving any intervening branch.*—This is only possible in aneurysm of the root of the common carotid, all other large arteries having too many branches. The cavity is filled at once as in embolism, but the blood-pressure soon falls; the tissues around expand again, the sac diminishes in size, and the blood that it contains probably coagulates at once. Sometimes the coagulum extends down into it from the seat of ligature. For aneurysms in that particular situation it is exceedingly suitable.

5. *Distal compression* has been tried in imitation, but, except in a few aneurysms of the abdominal aorta, it is of very little service. It throws the whole strain upon the sac without anything like the same certainty of coagulation.

6. *Introduction of foreign bodies into the sac.*—Of these, iron wire seems to afford the best prospect. As yet it has only been used in desperate cases of internal aneurysm, so that it must not be judged too harshly. In one or two it has been partially successful, but in spite of this it cannot be recommended until all other methods have been exhausted.

The wire must be sufficiently fine and flexible to coil up in the interior of the sac without exerting any degree of internal pressure; and especial care must be taken to bury the ends as effectually as possible. Usually it is passed in through one of Southey's trocars, the puncture being sealed with strong carbolic acid or the actual cautery. In the most successful case (Loreta's, one of abdominal aneurysm, in which the sac became consolidated and the patient lived for 92 days afterwards) only six feet were employed, and probably in some of the first the amount was unnecessarily great. Undoubtedly it causes coagulation of the blood, but the result is usually fatal from rupture of the sac at some weak spot, or from inflammation set up by the necessary manipulation.

It has been proposed to connect the wire with the positive pole of a battery and pass a continuous current through; but coagulation, in all the cases yet recorded, appears to have been induced with sufficient rapidity without this.

7. *Galvano-puncture.*—Coagulation may be started in the interior of an aneurysm by means of galvano-puncture, provided the part of the wall selected is not too thin, or the sac extending too rapidly; and possibly the clot so formed may change the direction of the stream and lead to the deposit of fresh layers over the weaker parts. The difficulty is that, especially in the case of thoracic aneurysms, for which this is chiefly used, it is almost impossible to form a definite idea as to the size of the orifice of communication, the direction in which the aneurysm is spreading, or the course of the blood-stream through it. Still, in some cases of sacculated aneurysm springing from the arch of the aorta, a very decided improvement has been effected with very small risk. Unhappily, accumulation of fibrin on the front of the sac (often the only part accessible) may be attended with, or may actually cause, rapid extension in some other direction, unknown and unsuspected.

Fine trocar-shaped needles are the best, insulated up to the neck with vulcanite; silk causes too much irritation, and sealing-wax or simple rubber does not adhere sufficiently. They are attached to the positive pole only: the negative, which should never be introduced into the sac, is connected with a large zinc plate, covered with wash-leather and soaked in salt solution. The patient can rest his hand on this and interrupt the current at any moment; but as the strength never should exceed five or six milliampères there is no pain or shock to cause any alarm even when the aneurysm s close to the heart. Two or more needles are introduced parallel to each other, well into the interior, until their external ends distinctly vibrate; then the current is turned on and continued until the movement ceases and the tissues around feel hard. The needles should be left in for an hour or so afterwards, in order that the clot may attain some degree of firmness and become fixed. Nothing, or at most a little blood-stained serum, exudes from the punctures, but it is as well to cover them with collodion. By repeated applications of this kind, I have succeeded in keeping in check an aneurysm of the aorta that had already caused partial absorption of the sternum; and with such success that for some time the pulsation disappeared from the intercostal spaces. Unhappily, sudden excitement one day caused a rapid extension of the tumour, and the skin became so much stretched and thinned that nothing further could be done.

8. *Acupuncture.*—In one or two cases, this has been tried with at least temporary benefit. Three pairs of long fine darning-needles were introduced into the sac, so that each pair crossed in the cavity. They were left in for five days, by which time they had caused a considerable degree of clotting; and this gradually increased until at length the sac became almost solid.

III. *Exclusion of the aneurysm*

This takes place when suppuration occurs round an aneurysm and the sac sloughs out. What is known as the old operation is carried out on the same plan; a free incision is made into the sac; all the clots turned out, and the artery tied above and below. With the aid of tourniquets, the primary hæmorrhage can be fairly well controlled; but as the artery in idiopathic or spontaneous aneurysm is almost certain to be extensively diseased on either side, the risk of secondary hæmorrhage is very great; and even if this does not occur, gangrene is exceedingly likely to follow. Practically it is reserved for traumatic aneurysm, embolic aneurysm of the upper limb in young people, and cases in which, after ligature of the artery, the sac has become inflamed and is beginning to suppurate, without the pulsation having ceased.

IV. *Amputation*

This may be required if moist gangrene sets in; for rupture of the sac; suppuration with threatened hæmorrhage; or disease of a neighbouring bone or joint. If secondary hæmorrhage occurs from the seat of ligature, an attempt may be made to secure the two ends of the artery *in situ*; but if it is clear that the walls of the vessels are seriously diseased, it is probable that amputation at once, if it is practicable, gives the patient a better chance of life.

Traumatic Aneurysm

The formation of traumatic aneurysm has been already described: an artery is injured and the cicatrix yields; or one of the coats is torn through, and the others are unable to stand the strain; or there is a wound plugged with a coagulum which gradually stretches under the influence of the blood-pressure; in any case a circumscribed sac containing fluid blood forms in connection with the interior of the vessel and grows larger and larger, the wall, as soon as it attains any considerable size, being formed of fibrous tissue thrown out by the inflamed and irritated structures around, and lined with laminated clot.

Its progress and terminations are similar in all respects to the idiopathic form; it may become filled with laminated fibrin, or with loose soft blood-clot; it may cause suppuration around; it may leak by slow degrees and then suddenly rupture into the cellular tissue; sometimes even it forms a communication with a vein (arterio-venous aneurysm); or it may at length end in gangrene of the part.

As a rule, the simpler methods of treatment succeed; a bandage is often enough if the part is kept at rest; or, if this does not answer, Reid's method, digital compression, or flexion may be tried. If these fail and the aneurysm is superficial, the old operation may be resorted to without hesitation, as the walls of the vessel are healthy; but if it is deeply seated proximal ligature (the Hunterian method) should have the preference.

Rupture or even leakage, unless of the most trivial description, leaves no alternative: then it is simply a question of a ruptured artery, and it must be treated as such.

SPECIAL ANEURYSMS

Aneurysms at the root of the neck

Many forms of aneurysm are met with at the root of the neck, and the differential diagnosis is often very difficult. Roughly, they are divided into three classes, although sharp distinctions are seldom possible, and the dilatation is rarely limited to one part.

1. Those confined within the thorax. These spring usually from the first part of the arch of the aorta, occasionally from the third. They may be sacculated; but very often, even when a sacculus is present, it is only secondary to a wider fusiform enlargement.

2. Those that pulsate in the episternal notch, or behind the sterno-clavicular articulation or the sterno-mastoid, so that part of the outline of the sac can be felt.

These include sacculated aneurysms of the transverse portion of the arch; those that spread from the aorta into the base of the innominate; and aneurysms of the innominate itself, involving more or less of the carotid or subclavian. Aneurysms springing from the left extremity of the arch, and spreading in the direction of the left carotid or subclavian, occasionally present in this region, but only in their later stages.

3. Those that lie entirely out of the thorax, the finger being able to feel the under surface of the sac. These must be either carotid or subclavian: even the high innominate form (so called to distinguish it from that which spreads upwards from the aorta) descends too far.

The diagnosis of these different conditions rests upon the position and extent of the tumour with regard to the surface of the body; the evidence of pressure upon structures near; and the alteration in the pulse-wave. Thorough examination must always be made of the heart, to ascertain whether there is any mitral or aortic regurgitation, and of the other arteries. Any surgical operation that is undertaken must be of the most serious description, and should never be attempted unless other conditions are favourable. Fusiform dilatation, aortic disease, atheroma in other vessels, hypertrophy or dilatation of any of the cavities of the heart to any serious extent, and renal disease, are practically final, so far as active treatment is concerned.

Even taking the small number of cases left, those in which there is merely a sacculated aneurysm springing from an otherwise healthy vessel, active surgical treatment cannot be recommended until rest, diet, and simpler methods have been thoroughly tried. How long they should be kept up before adopting further measures depends upon the amount of improvement in each individual case. A certain degree is almost invariable at first if a patient who has been engaged in hard manual labour is laid up in bed and kept on low diet; the heart beats less quickly and less forcibly; the tension in the aneurysm falls; the surrounding tissues empty it to a certain extent by their pressure; and the pulsation becomes less distinct. If this continues, nothing better can be wished for, and it may be hoped that the sac will gradually become solid. Too often, however, it is only temporary; all the symptoms return even after a patient trial for months, and without the patient undertaking any exertion. For such as these, if the other conditions already enumerated are favourable, it is sometimes possible to adopt a more active line with benefit; but the proportion they bear to the whole is exceedingly small.

1. Aneurysm of the first part of the arch. This lies for the most part to the right of the middle line, causing an area of dulness that corresponds chiefly to the second rib and the second interspace, although it may reach as high as the sterno-clavicular articulation. Protrusion of the chest-wall takes place comparatively early, and is soon followed by the formation of a distinct swelling which pulsates visibly and sensibly. Over this region the heart-sounds are heard with abnormal loudness, the second especially. The heart itself is often displaced outwards. There may be evidence of pressure upon the right bronchus, air not entering freely into the lung, or upon the superior vena cava, causing congestion of both arms and both sides of the head. The pulses are equal, carotid as well as radial, but the pulse-wave is slightly lower and more sloping than natural, and the down-stroke prolonged and undulating.

If rest and diet fail and the other conditions are sufficiently favourable, the choice lies between galvanopuncture, acupuncture, the introduction of foreign substances, simultaneous distal ligature of the right carotid and subclavian, and ligature of the left carotid. Of these the first three have never strengthened the sac sufficiently to enable the patient to lead an active life again, even for a time, and the last of them is very likely to end in embolism. Perhaps galvanopuncture is the best, especially if the current is kept up for some hours and the needles are retained until the clot is firm; but it has not yet been proved that the coagulum is capable of resisting for any length of time the immense force that must fall upon it in the first part of the aorta. The last two have each succeeded once or twice, although it was not known at the time that the aneurysm was situated in the first part of the arch. Ligature of the left carotid perhaps affords the best hope; it is not so serious an operation as the other, and if the rest of the aorta is not dilated, and the heart is not diseased, there is a possibility of its proving successful. The condition of the other carotid must, however, be carefully investigated first.

2. Aneurysms that pulsate in the episternal notch. This is the most difficult class of all; it does not follow by any means that a tumour originates upon the side upon which it projects.

(*a*) The area of dulness and the locality of the pulsation rarely reveal much. If there is a distinct band of resonance opposite the level of the second costal cartilage, it is probable that the first part of the arch is intact, but it is not common to find this even after the fullest inspiration. Also, if the pulsation is limited to the region of the right sterno-clavicular articulation, the aneurysm probably involves the innominate artery, but it does not show that the dilatation is limited to this, and it does not exclude those varieties of sacculated aneurysm which ascend from the arch in front of the other vessels and pulsate in exactly the same locality.

(*b*) Pressure signs are more useful. Veins are often obstructed, the superior cava when the first part of the arch is concerned, the right innominate if the aneurysm extends upwards along the innominate artery, the right internal jugular, if the first part of the subclavian is involved, and the left innominate when there is a pouch projecting upwards from the transverse part of the arch, along the innominate or independently. This last condition, in which the tumour, pulsation, and accentuated second sound of the heart are most distinct upon the right side, and the congestion upon the left, is very suggestive.

Nerves do not suffer quite so often. The left recurrent laryngeal is first irritated and then compressed in aneurysms of the distal portion of the arch, causing a peculiar paroxysmal cough with a high squeaky voice, and in the later stages aphonia. The right suffers in the same way when the first part of the subclavian or the innominate is dilated. In every case of suspected aneurysm the condition of the vocal cords as regards position and movement during phonation should be carefully examined.

The sympathetic is not affected unless the aneurysm assumes a particular direction or becomes very large. Vascular dilatation, increased sweating, and contraction of the pupil are the chief symptoms.

Compression of the trachea or of one of its divisions may occur in almost any of the forms; the tone of the voice is not affected; the breath-sounds are changed; there is a loud harsh blowing, often audible on both sides, even when only one is involved; violent fits of spasmodic coughing, ending in the expectoration of thick ropy mucus, are of common occurrence, and the expansion of the chest is often unequal.

In other cases the œsophagus, the lower cords of the brachial plexus on one side, the sternal end of the clavicle, or the sterno-clavicular articulation are affected as the growth increases in size, and give important indications as to the direction in which it is extending.

(*c*) The condition of the pulse affords even more valuable evidence than this, although it must always be remembered that the right subclavian sometimes runs an abnormal course, and may be compressed by an aneurysm springing from some other vessel. It is not, however, the absence of ulsation so much as the character, the peculiar, low, sloping, aneurysmal urve, that is important; and, to obtain satisfactory evidence of this, racings must be taken from both radials and both carotids. If those btained from the two sides are approximately equal, the aneurysm probably nvolves the first part of the arch, though it is by no means certainly limited o it; if the right are affected, but not the left, the arch itself must be nearly ntact; if the left without the right, the innominate must be sound; and he same with regard to the radial and carotid on either side.

If rest and diet fail, distal ligature is the only active treatment advisable or any of these, although one case of innominate aneurysm is stated to have een cured by distal compression of the subclavian and carotid. Galvanouncture or the introduction of foreign bodies does not offer the least prospect f success. Those cases, however, only are suitable for it in which the tumour is distinctly limited in size, and in which the presence of fusiform dilatation of the aorta, hypertrophy and dilatation of the left ventricle, &c., can be excluded. The choice lies between simultaneous ligature of the right carotid and subclavian, and ligature of the left carotid. The former is to be preferred, if from the condition of the pulse and the right venous congestion the symptoms point definitely to the innominate; the latter probably under other conditions.

3. Aneurysms of the right side of the root of the neck, lying outside the thorax. These are either carotid or subclavian. The reason for classing them here is the extreme difficulty of distinguishing them from the high innominate form.

In aneurysm of the first part of the subclavian the swelling appears first behind the clavicle, pushing that bone forwards and causing a rather elongated area of pulsation. Paroxysmal cough with alteration in the tone of the voice from pressure on the recurrent laryngeal, venous congestion and œdema of the side of the head and neck from compression of the internal jugular, and weakening of the radial pulse are the chief distinctive signs.

When the base of the right carotid is involved the shape and position of the tumour and the direction of the pulsation are different; there is no pressure upon any nerve or vein, no dulness in the first intercostal space, and nothing in connection with the trachea, œsophagus, or recurrent laryngeal, until the tumour reaches a considerable size. On the other hand, the facial and temporal pulses are distinctly different from those on the opposite side.

If these two sets of symptoms occur together, even if they are only slightly marked, it means that the distal end of the innominate is involved; that practically it is a case of innominate aneurysm (the high form in distinction from the low one which spreads upwards from the aorta); and, as already described, that it can only be treated by rest and diet, or by simultaneous double distal ligature.

Aneurysms of the Carotid

The point of bifurcation is the most common situation, but almost any part, except that which lies inside the thorax on the left side, may be involved. The internal carotid is seldom affected, although a few cases are on record; and most of those in connection with the external are traumatic, and extend along its branches. It is peculiar that aneurysms of the common trunk are nearly as frequent among women as among men.

Two varieties are distinguished, the high and the low; the latter is almost if not quite confined to the right side.

Symptoms.—In addition to the ordinary sign, the presence of a circumscribed fluid tumour with characteristic pulsation and bruit, there are others caused by pressure upon neighbouring organs, and by interference with the cerebral circulation. Among the former may be classed dyspnœa, spasmodic coughing, and hoarseness from pressure upon the trachea, larynx, or recurrent laryngeal; dysphagia from the sac projecting into the pharynx or œsophagus (this is more common when the internal is affected); contraction of the pupil and other symptoms from paralysis of the sympathetic; and neuralgia from pressure upon the cervical nerves. The latter are due either to loss of arterial tension in the vessels of the brain, in the same way as in the flow in the internal jugular. Giddiness, syncope, noises in the ears, dimness of vision, headache, and violent throbbing, are not unfrequently present; and in addition there is always the risk of embolism, with paralysis of smaller or larger centres, from some fragment of clot being detached.

The diagnosis in many cases is exceedingly easy, in a few, however, it is a matter of the greatest difficulty. Aneurysmal dilatation is not at all uncommon at the bifurcation, and at the origin of the right common trunk; and if noticed suddenly for the first time, or if it accidentally becomes more prominent from wasting of the tissues around, it may cause considerable uneasiness. Probably the cases in which carotid aneurysms are recorded as having lasted unchanged for years were really examples rather of fusiform expansion than anything else. At the root of the neck, even if the diagnosis of aneurysm is certain, it may be impossible to prove that the carotid only is involved; aneurysms of the subclavian, the innominate, and even of the arch of the aorta, may simulate it perfectly, so far as position is concerned. Glandular enlargements are usually lobulated and multiple, and the only difficulty occurs when the artery runs through the centre of a mass of them. A few cases of cysts lying on the artery are on record, but the character of the pulsation is different, and although fluctuation is distinct the contents cannot be emptied out of the sac by pressure. Vascular growths of the thyroid, which occasionally pulsate, move up and down with deglutition, and can be traced into connection with the isthmus. Abscesses and pulsating malignant growths rarely give rise to trouble; the shape of the swelling, the relation it bears to the vessel, the absence of expansile pulsation, and the effects of distal and proximal compression, are sufficiently distinctive. When the aneurysm is situated on the internal carotid, pressing against the tonsil, and causing it to project into the pharynx, it may be mistaken for an abscess.

Spontaneous cure is very rare. Some cases remain quiet for a long time without enlarging, but the general tendency is for the tumour to increase until it ruptures into the pharynx, trachea, or externally. Suppuration may occur round it, especially after ligature, and embolism of the cerebral arteries, leading to hemiplegia, has happened in several cases—once, at least, while the tumour was being examined.

The only treatment possible is compression or ligature, proximal or distal.

The common carotid may be compressed with the fingers against the transverse process of the sixth cervical vertebra, or above this by grasping the artery behind the sterno-mastoid, between the finger and thumb, the patient's head being bent over to the affected side so as to relax the muscle. Instrumental compression is rarely successful. In any case, even when the greatest care is used, it is almost impossible to stop the flow of blood for more than two minutes, and often not for that at first, vertigo, faintness and a sense of sickness coming on almost at once. Whether this is due to the nterruption of the circulation, or in part at least to the irritation of the vagus and sympathetic, is uncertain. It is more important that after a number of sittings a certain degree of tolerance is established.

If this fails, proximal ligature must be tried if there is room, distal if here is not. Neither is very successful, and it has been proposed, especially n traumatic cases (which, however, are too rare to enter into the question) o resort to the old operation. There is some reason, however, to believe that recent results are a good deal better. Suppuration of the sac, and hemiplegia and convulsions from cerebral anæmia, are not unusual consequences. Occasionally pulmonary congestion and hypostatic pneumonia occur, possibly from interference with the blood-supply of the base of the brain, but more probably from injury sustained by the vagus or the cardiac branches of the sympathetic.

Aneurysm of the external carotid presents no special features. The artery itself should always be secured in preference to the common trunk, if it can possibly be managed, as this avoids one of the most common causes of death. Sometimes it is necessary to tie one or more of the branches as well, owing to the special freedom of the collateral circulation.

Aneurysm of the extra-cranial portion of the internal carotid can only be treated by pressure or proximal ligature.

Aneurysmal varyx occasionally occurs in the neck, as a result of stabs and other wounds, involving an artery and a vein. It is most frequent in connection with the common or internal carotid and the internal jugular; but it has been known to form between the common carotid and the subclavian vein, just where they cross. The immediate effect of such an injury is an enormous extravasation of blood; if this does not prove fatal, or end in suppuration, the orifices in the vessels lying opposite each other may unite and prevent further loss. The symptoms are those already described, violent pulsation in the veins with dilatation and hypertrophy, palpitation arising from the unequal pressure in the auricle and the unusual character of the blood, and headache, giddiness, noises in the ears, &c., from interference with the cerebral circulation. In most cases there is a distinct thrill along the course of the vein; and a whizzing or purring noise can nearly always be heard, more or less, over the whole of that side of the head. Not unfrequently it is very distressing to the patient, even preventing sleep. Treatment should be palliative only.

Orbital Aneurysm

Orbital aneurysm is a clinical term used to describe certain pulsating tumours of the orbit, attended with exophthalmos, without implying the invariable presence of any single pathological lesion.

In those past middle life it may originate spontaneously or after some slight exertion, or at any age from such accidents as fracture of the base of the anterior fossa of the skull, gunshot injuries or penetrating wounds of the orbit. Usually the symptoms appear within the first few months, often within a few days. At first there is merely a loud buzzing or roaring sound audible to the patient, then the conjunctiva becomes congested and perhaps chemosis follows. After a while the eyeball projects and begins to pulsate, the ocular muscles lose their power, the pupil becomes fixed, the hollow under the orbital arch is filled up, and a soft pulsating mass makes its appearance at one angle of the orbit, usually the upper and inner. The veins of the eyelids, the bridge of the nose and the forehead soon become distended and tortuous; a distinct thrill and a loud rasping bruit are perceptible over the swelling; a large pad of infiltrated mucous membrane protrudes between the lids; the pulsation of the eyeball becomes more and more distinct, and in many cases the transparency of the media is destroyed.

Before this occurs it may be noted with the ophthalmoscope that the disc is unduly prominent and the retinal veins enlarged. Small hæmorrhages, too, may be present. Finally the opposite eye and orbit may become affected in the same way, and in extreme cases the dilatation of the veins may extend over a great part of the face.

The noises in the head and the bruit cease as soon as pressure is applied to the carotid on the corresponding side; if it is kept up the globe recedes and the pulsation diminishes or stops altogether.

It has been clearly demonstrated by Rivington that the pathological lesion underlying this condition is probably always a communication between the internal carotid artery and the cavernous sinus, sometimes caused by injury, sometimes due to the rupture of an aneurysm or the giving way of the floor of an atheromatous ulcer. The immediate effect is the rush of arterial blood under high pressure into the ophthalmic vein, causing at first merely pain and a peculiar buzzing noise audible to the patient; but later, as the vein becomes enlarged and distended, and as with its increasing size the pressure in its interior becomes greater and greater, giving rise to the exophthalmos and the signs of aneurysmal varix extending on to the face. The communication between the two cavernous sinuses explains the fact that one eye may become affected after the other.

Aneurysm of the ophthalmic artery may cause exophthalmos, but cannot produce a pulsating tumour at the angle of the orbit, or the distension and thrill in the veins. The venous sinuses of the cranium not unfrequently become thrombosed, but do not of themselves lead to the development of pulsating tumours, although they may cause some degree of proptosis with passive congestion of the eyeball, dilated pupil, restricted movements and diminished vision. Aneurysms of the internal carotid (unruptured) may project into the cavernous sinus without giving rise to the essential symptoms of this disorder. The rare examples of erectile and cavernous tumours met with in the orbit might produce something of the same character, but without pulsation or bruit. Cirsoid aneurysm undoubtedly could, but it has never yet been found in this locality, and Rivington suggests that in many cases, in other parts of the body, especially where it has followed injury, it is really a form of aneurysmal varix itself rather than true cirsoid aneurysm.

The greatest difficulty occurs with pulsating sarcomata growing from the back of the orbit. For a time at least they may cause symptoms of an almost identical character, but the bruit is usually absent, and when it is present is of a very different description; and extension of the growth always takes place very rapidly.

Treatment.—The only treatment at all satisfactory in its results is compression or ligature of the common carotid. The former has seldom been tried, owing to the difficulty of maintaining it for more than a minute or two; but probably it deserves more attention than it has received. The latter has been very successful both in the traumatic and, though to a less extent, in the spontaneous variety. In one or two instances both vessels have been tied, though not at the same time, owing to persistence or recurrence of the symptoms. This may have been caused by the clot being washed away before organisation had rendered it sufficiently firm; or by unusual freedom of communication between the two cavernous sinuses; or by the blood having found its way into the orbit through other veins as well as the ophthalmic. Vision is lost in a large number of cases, chiefly from ulceration of the cornea and collapse of the eyeball. This may sometimes be checked by early operation, certainly it is favoured by delay; but it is impossible to predict what will result in any given case, as the ligature of the vessel itself under these circumstances may so interfere with the circulation through the eye as to impair the transparency of the media.

Aneurysms of the Subclavian

These, like aneurysms of the carotid and innominate, may be divided into two classes: those which are limited to the third part of the artery, that which descends beneath the clavicle, terminating at the lower border of the first rib; and those which implicate the first part, whether they are limited to this or extend over the rest as well. Like aneurysms elsewhere (with the exception of the carotid), they are much more common in men than women, and, for the most part, occur upon the right side.

Subclavian aneurysms rarely attain any large size before rupture takes place. They usually form an elongated swelling behind and above the clavicle, with all the characteristic signs of aneurysm, pulsation, bruit, &c. The pressure-symptoms vary according to the locality; when the inner part is concerned, the recurrent laryngeal nerve and the internal jugular vein are compressed; when the outer, the subclavian vein, the external jugular and some of the cords of the brachial plexus. In general, the prominence is chiefly upwards, but occasionally the sac enlarges in the direction of the pleura and it may become adherent to it; and sometimes the phrenic nerve, the trachea, and the œsophagus are compressed.

Enlarged glands may, as in the case of the carotid, surround the vessel and lead to a certain amount of difficulty in diagnosis; and chronic abscess may occur in connection with them or with other structures, and produce at first sight a closely similar appearance; but the effect of compression upon the artery or upon the sac is conclusive. The difficulty of determining how far inwards the dilatation extends is often very great, especially on the right side; but, as a rule, the comparison of the pulse in the branches of the carotid on the two sides is enough to determine whether the innominate is involved or not.

Spontaneous cure is said to have occurred in a few cases from embolism. As a rule, the sac enlarges very slowly for a time, and then suddenly gives way, causing an immense extravasation, which may prove fatal from pressure, or may burst into the pleura, the trachea, or externally.

The treatment of subclavian aneurysm is most unsatisfactory. Proximal ligature, unless the aneurysm is really axillary rather than subclavian, is practically hopeless. Ligature of the innominate or of the first part of the subclavian on the right side has proved almost invariably fatal from secondary hæmorrhage; while on the left side ligature of the corresponding trunk is out of the question. Proximal compression is equally impossible, except in the case of some rare anatomical abnormality.

Distal ligature has not proved any better, probably owing to the very large collateral branches coming off from the sac itself or its immediate vicinity. Amputation at the shoulder-joint has been performed on one or two occasions with the view of meeting this, but without sufficient success to justify repetition.

Rest and diet should be thoroughly tried in every case first. If they do not succeed, and the sac contains sufficient fibrin, direct pressure with manipulation affords the best hope, always provided the carotid is not nvolved. Under other circumstances, prolonged galvano-puncture would robably answer better; or an attempt might be made to procure solidifica- ion by the introduction of a short length of iron wire; but the prognosis in ll such cases is very grave, and the risk of suppuration setting in very reat.

Axillary Aneurysm

This is chiefly remarkable for the rapidity of its development and the requency with which it can be traced to a definite injury. As might be xpected, it is much more common among men than women, and nearly lways occurs upon the right side. Any part of the artery may be involved, nd it may project downwards into the axilla, inwards towards the thorax, o that the ribs become absorbed; or upwards under the clavicle, raising he shoulder. The movements of the arm are naturally restricted, the head s inclined to that side, the elbow is abducted, and not unfrequently there is reat pain running down the arm from pressure upon the brachial plexus, r œdema from occlusion of the axillary vein.

Spontaneous cure is very rare, if it ever happens. If left to itself, the ac rapidly enlarges and either becomes inflamed and suppurates (to which is especially prone) or ruptures into the loose cellular tissue of the axilla, he shoulder-joint or the thorax.

The treatment, if the aneurysm is limited to the axilla, is comparatively imple. Compression of the third part of the subclavian should be tried rst; but after a short time it usually becomes exceedingly painful, and if it kept up is not without danger to the brachial plexus. If it cannot be orne, Esmarch's bandage may be used under an anæsthetic, the circulation bove being controlled with a rubber cord arranged round the axilla in a gure-of-eight, as high as possible; or a ligature may be placed round the hird part of the subclavian. When, however, the clavicle is pushed up by n immense tumour, and it is doubtful how far the aneurysm is subclavian nd how far it is axillary, the question becomes much more difficult. Rest nd diet may succeed, but usually the tumour continues to increase un- hecked. Direct pressure and manipulation are not suitable, owing to the inness of the sac and the rapidity of its growth, while galvano-puncture nd the introduction of foreign substances are almost sure to excite inflam- ation and very possibly suppuration. The best chance lies in ligature of e subclavian as far away as possible, dividing the scalenus anticus, and rawing the phrenic nerve inwards out of the way, if it appears necessary. ny branch that comes off from the main trunk near the seat of ligature ould be tied too, to diminish as much as possible the risk of secondary emorrhage; but the operation is one of extreme difficulty, and, owing to e manipulation necessary, is very likely to be followed by inflammation ther of the sac or of the pleura and its contents.

Aneurysms of arteries below the axillary are rare except as a result of nbolism or injury. There is nothing special either in their symptoms or eir treatment.

Abdominal Aneurysm

Fusiform, dissecting, and sacculated aneurysms are described in connec- on with the abdominal aorta and its branches. The last is the most mmon and is the only one capable of treatment.

It may occur at any part and may either involve the roots of some of the large branches such as the cœliac axis, or may cause their obliteration by its pressure. Usually it projects forwards in the direction of least resistance; but instances have been known of aneurysms originating on the posterior surface, and eating their way into the bodies of the vertebræ. Generally there is a distinct history of injury, or, if not, of some especially laborious occupation; when there is not, when the dilatation is apparently spontaneous, it is probable that the vessel is seriously diseased. One or two instances of spontaneous recovery are recorded, the condition not having been even suspected during life.

The symptoms are very obscure until the sac has attained a considerable size. Pain is usually present, but it varies very much in character; in some cases it is continuous, in others paroxysmal; sometimes it radiates along the course of the nerves, at others it is fixed and localised; and the character is equally vague. Pulsation of the typical expansive description with a distinct systolic bruit, audible behind as well as in front, is nearly always present from the first, but often it is not noticed until it compels attention. Dyspnœa may occur from pressure upwards towards the diaphragm; dyspepsia, colic, constipation, and other troubles from interference with the stomach and intestines. Jaundice has been known from compression of the bile-duct. The liver may be displaced, or the left kidney; but uræmia, anasarca, ascites, and other troubles that arise from pressure upon veins are seldom met with. The tumour is generally fixed, not moving with the diaphragm; and the pulsation is usually most marked a little to the left of the middle line; but especially when the upper part of the vessel is concerned it may require very deep pressure to feel it at all.

Diagnosis.—The chief difficulty occurs in connection with a form of dilatation which, especially in thin subjects, may be so striking and so distinctly expansive as to simulate aneurysm very closely. Lumbar and psoas abscess; solid tumours resting on the front of the aorta; and pulsating growths in connection with the vertebræ may be mistaken for it. Aneurysm of the cœliac axis usually projects forwards towards the right side under the liver; when the superior mesenteric is involved the tumour is more movable, but this does not hold good when the origin is affected. The character of the pulse-wave in the lower extremities should always be carefully investigated, although it does not give very clear indications owing to the difficulty of comparison.

As a rule, the course of the disease is very rapid; the structures round yield readily and there is nothing to restrain the growth of the tumour. Death is usually sudden from rupture into the peritoneal cavity, but occasionally leakage is more slow and an ill-defined swelling forms in the iliac on lumbar region, and delays the end for a few days. A very marked degree of emaciation is not uncommon; and the loss of strength and exhaustion, partly from the interference with the circulation, partly from digestive troubles, want of sleep, and pain, may be so great as to prove fatal before the sac gives way.

Treatment.—Although one or two instances of spontaneous cure are known to have occurred, the treatment by rest and diet holds out a very slender chance. Probably this is due in great measure to the absence of support from the tissues around, and to the high degree of pressure in the sac. If there is no material improvement within a fortnight or three weeks, there is ɔt likely to be any afterwards; and then it becomes a question whether mething further should be attempted.

This depends upon the position of the aneurysm, whether it is above or low the renal arteries; on its shape, whether it is sacculated or not; on s origin, whether it was spontaneous or distinctly traumatic; and on the ndition of the heart, the kidneys, and the other vessels.

If everything is favourable, the choice lies between proximal or distal essure and opening the abdomen and introducing foreign substances into e sac, as in Loreta's case already mentioned. Proximal pressure is ndoubtedly the best of these; but, without opening the abdomen, it cannot e effected above the renal arteries; the aorta lies too deeply and is covered ith structures, especially the pancreas, which may not be bruised. If the bdomen is opened, as has recently been done by Keetley, pressure can be pplied almost directly to the vessel, but of course in such a case this itself a serious matter. The bowels must be thoroughly cleared out with perients and enemata, the bladder emptied, and care taken that the omach contains no solid food. Then the patient must be placed under an næsthetic, and Lister's or Carte's tourniquet carefully adjusted above the welling, and slowly screwed down until the pulsation of the aneurysm is hecked. It need not be said that this is only possible in a very limited umber of cases. Once fixed, no current should be allowed to flow through ntil it is determined to bring the procedure to an end; any rush of blood, uch as would ensue from relaxing the pressure too soon, would at once weep the coagulum away. How long compression can be maintained epends upon the condition of the patient. If there is no sign of shock, it ay be kept up for three or perhaps four hours; and possibly at the end of at time pulsation may be so much diminished that consolidation will follow itself. In several cases, however, peritonitis has occurred, and proved tal from the amount of bruising. Afterwards, and for some time, the tient must be kept as quiet as possible in the hope that the coagulum will main firm.

Where this cannot be carried out, distal compression may be tried. In few instances the two have been used together so as to ensure complete ssation of the circulation through the sac. By itself it is certainly not so ectual.

Cessation of pulsation is attended by great loss of power with coldness d deficient sensibility in the parts below. After a time, if they are kept rm and protected from injury, this passes off and pulsation can be ected in the larger trunks again; but naturally the collateral circulation, man at least, can scarcely become sufficiently developed to replace the ta.

ILIAC ANEURYSM

Aneurysm of the common, external, or internal iliac artery forms a soft umscribed swelling in the line of the vessel, with characteristic expan- pulsation and bruit continued along its course. The pain is rarely ere unless the obturator or genito-crural nerve is involved; and owing to space around, other signs are often wanting until the tumour has hed a large size. If left it usually ends in rupture; but in one or instances œdema and gangrene have occurred from venous obstruc- .

Diagnosis.—Aortic aneurysm, springing from just above the bifurcation, has been known to spread down as low as Poupart's ligament. Enlarged glands round the artery may cause a momentary doubt. Tumours growing from the bones, especially pulsating sarcomata, are much more difficult; but in most cases they may be distinguished by their extent, position, attachment to the bone, feeble ill-defined bruit, and different pulsation. Moreover, they cannot be emptied by pressure; they do not alter the pulse-tracing in the same way; and the bruit (when there is one) is not carried along the artery. Abscesses in the same region require careful examination, as aneurysms not unfrequently send outlying pouches, which scarcely pulsate, under Poupart's ligament. In every case the rectum should be thoroughly explored.

Treatment.—This depends upon the position, whether the common trunk is affected, or merely that part of the external branch which lies near Poupart's ligament. In the former case, if rest and diet do not soon effect a decided improvement, the same treatment must be adopted as for aneurysm at the bifurcation, proximal pressure with or without distal. If low down, either the same plan may be tried, or the common or external iliac may be ligatured according to the height to which the sac ascends. Where neither of these methods is practicable, galvano-puncture affords the best hope; distal ligature has never proved successful, and the injection of coagulants (although perchloride of iron once very nearly succeeded) is almost certain to give rise either to gangrene of the limb or suppuration of the sac.

ANEURYSM OF THE BRANCHES OF THE INTERNAL ILIAC

The gluteal, and less frequently the sciatic and pudic arteries, are occasionally the seat of aneurysms, the majority being traumatic in origin. In some cases, especially when the sciatic is concerned, the sac lies partly inside the pelvis, partly outside; in most it is altogether extra-pelvic. The mode of origin gives no clue to this, as either of the arteries may be wounded in the sacro-sciatic foramen and then retract; the only way in which it can be ascertained is by rectal, or, in the female, vaginal examination.

Symptoms.—When the aneurysm is small, these are very vague, owing to the depth at which it is situated There is pain along the course of the sciatic nerve; the movements of the hip are limited, especially in the direction of flexion; and usually there is a hard, deep, ill-defined swelling Pulsation and a bruit are rarely absent when it has reached any size, but so long as the sac is small it is very difficult to make certain. If left, spontaneous cure is possible but very rare; much more often the sac continues to enlarge; the muscle and the tissues over it waste; and at length rupture takes place. There is no means of telling sciatic from gluteal aneurysm although the former is more probable if the sac can be felt inside the pelvis.

Diagnosis.—*Pulsating sarcoma.* In its early stages this is very difficult later, rectal examination or puncture with a fine trocar and cannula wil give sufficient evidence. A bruit is greatly in favour of the tumour bein aneurysmal, as it is rarely present in a sarcoma until this has attained considerable size, and even then it is much softer in tone.

Abscess. The absence of pulsation and bruit is usually sufficient in ronic abscesses, the signs of suppuration in acute ones, but it must be re- embered that gluteal aneurysms not unfrequently suppurate.

Enlarged bursa. The subgluteal bursa may become distended with lood or serous fluid, but there is no bruit or pulsation, in spite of the thin- ess of the walls, and there is no tension upon the contents.

Arterial hæmatoma. Unless there is a distinct history of injury, or a icatrix or some other evidence a definite diagnosis may be impossible. The pidity of formation and extension, the absence of pulsation and bruit, the nsion and inflammation of the parts around are equally suggestive of abscess, rterial hæmatoma and ruptured aneurysm. Of these the first can be ex- luded by means of an exploratory puncture; the other two are identical and quire the same treatment.

Treatment.—Constitutional treatment should be tried in these as all other kinds of aneurysm first; if they fail, resort must be had to peration.

Pressure cannot be carried out, unless applied to the bifurcation of the bdominal aorta. Perhaps this might be worth a trial first, under an anæs- hetic. In the intrapelvic form ligature of the internal or common iliac is ery serious, as aneurysm rarely involves this part of the vessel without xtensive atheroma. In the extra-pelvic one, the old operation, laying the hole sac open, necessitated an incision in Syme's case nearly two feet long, nd this was followed by extensive necrosis and suppuration. Probably, herefore, unless the sac has already given way, these aneurysms are best reated by galvano-puncture, or even the injection of coagulants such as per- hloride of iron. If suppuration occurs and bleeding follows the opening of he abscess, the cavity must be packed from the bottom. Embolism would ot be so serious a matter as in most other parts of the body.

FEMORAL ANEURYSM

Aneurysm may occur in the course of the common, the superficial, or he deep femoral artery. Usually it is sacculated, but occasionally fusiform; ometimes in Hunter's canal it is rather flattened.

As a rule there is no difficulty in the diagnosis, all the characteristic igns being present, but not unfrequently it is almost impossible to dis- inguish whether the dilatation is on the superficial or the deep branch; the ormer of the two is much the more common, and affects the pulse below to greater extent, but this cannot always be relied upon. Of course if the ulsation of the superficial trunk can be distinctly made out overlying the leep one, there is no difficulty.

The treatment consists in proximal pressure, instrumental or preferably igital, and if this fails, ligature. If the aneurysm is in Hunter's canal, the ame artery may be tied higher up; if in Scarpa's triangle, or if the profunda involved, the choice lies between ligation of the external iliac, or of the ommon femoral. The former is usually preferred, owing to its freedom from ranches at the seat of ligature, the better development of the collateral irculation, and the fact that it is less frequently atheromatous; but the tter has been shown to be very successful in actual practice.

Popliteal Aneurysm

The popliteal artery is the most common seat of aneurysm, except the aorta itself. It is peculiarly liable to atheroma; it is not supported by the structures around; it is compressed more or less in flexion of the knee, stretched out in over-extension, sometimes even ruptured; and immediately below it breaks up into a number of branches, so that an embolus, if it comes down the vessel, is almost certain to lodge there. That constitutional causes are of very great importance is shown by the fact that it sometimes occurs on both sides, and that it may even develop upon the second while the patient is lying in bed being treated for the first.

Fusiform dilatation is occasionally met with, but sacculated aneurysm is much more common. In some cases it springs from the anterior surface of the artery, and grows forwards against the bone or the posterior ligament of the knee-joint, and then it is usually slow in its course, rarely attaining a large size. In others it extends backwards, and, meeting with little to oppose it, becomes immense, forming a thin-walled sac within comparatively a short space of time.

Symptoms.—Occasionally the onset is sudden, dating from some exertion; more frequently the patient suffers from obscure rheumatic pain down the leg with stiffness of the joint and a sense of weakness, and then suddenly discovers, or has discovered for him, the presence of a pulsating swelling. Usually the expansive pulsation, the bruit conducted down the leg, and the way in which the sac empties upon compression, and fills again on relaxation of the vessel are distinctive. Occasionally the tumour is harder and cannot be emptied, the pulsation is that of an artery only, and the bruit is indistinct and faint; and in some very rare instances there is no pulsation at all. Probably, in the former case, the sac is already partly filled with fibrin, and possibly in the latter it is completely solid; but as pulsation sometimes makes its appearance later, this explanation is hardly satisfactory.

If the sac grows forwards, synovitis of the knee-joint sets in, the pain is very severe and movement greatly restricted. If it takes a direction backwards, the popliteal vein may be compressed, and congestion and œdema follow; or the internal popliteal nerve may be stretched so that there is severe neuralgia extending down the side of the limb into the sole of the foot. Sometimes a distinct difference can be made out in the two tibial pulses.

Left to itself it occasionally undergoes spontaneous cure. Much more frequently it grows larger and larger, leaks, and ruptures either into the knee-joint, or more usually into the cellular tissue of the leg. In either case the patient is conscious of something having given way, and becomes sick and faint with the pain and loss of blood. If the rupture takes place through the posterior ligament the knee becomes immensely distended at once, but the bruit and pulsation do not altogether cease, and the pulse can still be felt, though feebly, in the posterior tibial. If it is into the cellular tissue a tense swelling forms rapidly in the popliteal space, filling it completely and causing the most severe pain; the limb below becomes cold and livid the tibials cannot be felt, and in a very short time gangrene sets in. Occasionally inflammation breaks out round the sac, the skin becomes red œdematous and exceedingly painful, and sometimes this is followed by suppuration.

The diagnosis must be made from sarcoma growing either from the bones, the posterior ligament of the knee-joint, or the lymphatic glands ; abscess ; bursal cyst, or diverticulum from the knee-joint ; and solid tumours resting upon the artery. Arterial hæmatoma from perforation of the popliteal artery gives rise to the same symptoms as a leaking or a ruptured aneurysm, according to the size of the opening. In one case under my care there was a distinct bruit with faint pulsation along the course of the vessel.

Treatment.—Rest and diet are employed here only as adjuncts, but they should never be neglected, and unless the sac is enlarging rapidly, so that there is fear of rupture, it is always advisable to submit the patient to a few days' preparation before employing any active treatment.

If the aneurysm is of moderate size only, and there is no fear of immediate rupture, Reid's method with Esmarch's bandage, or digital compression, is the best ; preference being given to the latter if there is much evidence of atheroma or of heart-disease ; to the former if, other things being suitable, there are enlarged glands in the groin. Flexion succeeds well with those that are small or already partially solidified.

If these measures fail, or if the sac is enlarging rapidly and perhaps leaking, or if inflammation has set in, or if there is any œdema of the foot from pressure upon the popliteal vein, the artery should be tied at once at the apex of Scarpa's triangle, and the limb well wrapped in cotton-wool and raised.

Moist gangrene after ligature, rupture of the sac into the cellular tissue or into the knee-joint, disease of the knee-joint, caries of the lower end of the femur, and suppuration round the sac, require amputation. If dry gangrene occurs, the parts may be covered with some antiseptic powder, raised, and wrapped in cotton-wool, in the hope that a line of demarcation will form. Recurrent pulsation after ligature must be treated by compression, Esmarch's bandage, or flexion ; if these fail and the patient is a young man with the rest of his arteries healthy, the external iliac may be tied ; if old, it would probably be better to amputate at once. If secondary hæmorrhage occurs from the seat of ligature, the wound must be opened and both ends tied ; if this does not succeed, or the wound is in such a condition that success is improbable, amputation should be performed.

SECTION IV.—OPERATIONS ON ARTERIES

ARTERIES may require to be compressed so as to check the flow of blood for a time, or ligatured. In either case it is usual to select certain points owing to their being more accessible, or further removed from important structures, or because of the condition of the collateral circulation. Wounds of arteries have been already dealt with.

GENERAL RULES FOR LIGATURE

The position of the patient must be such as to bring the artery as near the surface as possible, and at the same time make the various anatomical features of the limb stand out distinctly.

The exact course of the vessel must be made out by feeling for its pulsation where this is possible, and by making use of the ordinary anatomical guides. In many cases it is advisable to mark it out upon the skin with an aniline pencil. Careful examination must be made for any abnormality either of the trunk itself or of its branches.

Other things being equal, the spot selected should always be far away from any large branch. If this is impossible, or if when the artery is exposed it is found that one is near, it should be tied as well.

As a rule the incision should be in the course of the vessel, over it (exceptions will be mentioned later on), the middle corresponding to the spot at which the artery is to be tied, and the length depending upon the amount of fat that is present and the depth of the vessel.

The first incision should divide the skin and the superficial fascia, taking care to avoid any large subcutaneous veins, such as the internal saphena, or the external jugular.

The deep fascia should be divided on a director to the same extent, and this holds good for every other incision ; the bottom of the wound, that is to say, should be kept throughout in the same plane, not deeper in one part than in another.

Each anatomical structure must be recognised as it is exposed, the operator carefully making out the various landmarks in turn.

Muscles, when identified, should be drawn to one side, the fascia which binds them down being divided if necessary, and the position of the limb being changed if they are too tense.

The sheath of the vessel is recognised by its position, by the pulsation of the artery, and by the sensation the finger receives. When an artery is compressed it feels like a flattened band with thick and rounded edges, and it empties beyond the finger ; a vein can hardly be felt at all, while a nerve is round and solid.

The sheath is formed of dense fibrous tissue, and in the larger arteries is separated from the outer wall of the vessel by more or less of a space traversed by minute blood-vessels and delicate connective tissue. In many cases the vein is enclosed with it, in a separate compartment, and sometimes a nerve as well. The nutrition of the coats of the artery depends almost entirely upon the vessels it receives in this way, and consequently the opening must be as small as is conveniently possible, the sheath must be separated as little as can be, and care must be taken to open the right compartment. The loose areolar tissue that covers the sheath is lifted up with a pair of forceps at one spot, so as to form a small cone; the side of this is cut with a scalpel held upon the flat, so that the edge does not at any time face the artery, and an opening made sufficiently wide to see the bluish-white external coat of the vessel beneath. One edge of this opening is held up with a pair of fine forceps, to make it tense, and the vessel gently separated from its sheath with an aneurysm-needle, or a director. The other edge is then laid hold of and the process repeated on that side, until the whole circumference is detached for a very short distance. The aneurysm-needle is then passed round (unthreaded), keeping as close to the wall of the vessel as possible, and beginning on the side that faces the most important structure, whether it is vein or nerve. As the needle passes round, the opposite edge of the opening in the sheath should be seized with forceps and drawn outwards in order to straighten out the route. Sometimes a few strands of tissue covering the point of the needle require division with the finger-nail, or even with the scalpel, but great care should be taken to keep the edge and the point away from the vessel as far as possible (fig. 45).

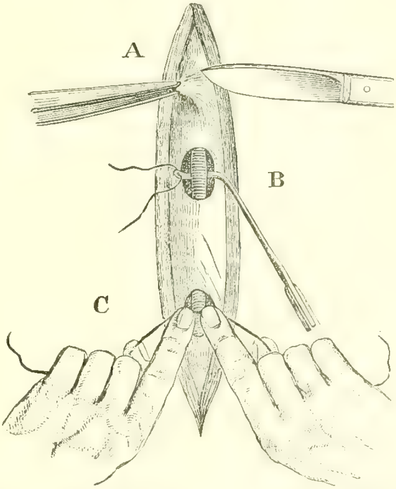


Fig. 45.—This diagram represents three distinct operations. A. Opening the sheath. B. Drawing ligature round the artery. C. Tying artery.

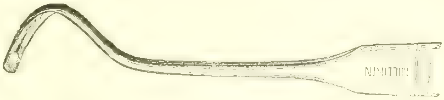


Fig. 46.—Aneurysm-needle.

When the needle has been passed, the vessel is compressed against it with the finger, to make sure that it is the artery (pulsation ceasing beyond) and that nothing else is included with it. Then the needle is threaded and withdrawn.

A reef-knot should always be used. A few attempts have been made to substitute a loop or hitch to avoid the projection, but the same reliance cannot be placed upon it. The amount of pressure should be sufficient to draw the inner coat well together. Whether this will divide it and the middle depends upon the shape and material of the ligature. With a flat band (such as Barwell's ox aorta) it certainly will not; with stout catgut it is very doubtful; with fine gut, kangaroo tendon, or silk, there is no question. In any case, the greatest care should be taken, in tying the knot, not to lift the vessel unnecessarily from its bed; the fingers must be brought down to it.

When a double ligature is used and the artery divided in between, it must be separated from its sheath for some little distance; how far depends upon its size. The object is to enable the two ends to retract thoroughly. The portions that lie beyond the ligatures are practically cut off from the circulation, in the same way as the end of an artery that is tied or twisted on the face of a stump, and like it either slough or become infiltrated with organising lymph, according to the behaviour of the wound and the addition or not of suppuration. This plan should be adopted in every case in which a sufficient length of artery can be exposed without interfering with the part too much.

Ligature of the Innominate

The line of the artery runs from the middle of the manubrium to the right sterno-clavicular articulation ; the point of bifurcation is usually just below the upper border of the joint.

The patient lies on his back with the shoulders slightly raised and the head turned towards the left. The operator stands upon the right side.

The incision is triangular : one side extends for three inches along the inner border of the right sterno-mastoid, ending on the sternum ; the other outwards from the lower end of this along the upper border of the clavicle ; the flap so formed is reflected outwards on its base.

The sternal head of the sterno-mastoid and the greater portion of the clavicular one are divided upon a director, close to their origin, and reflected in the same direction as the skin. The anterior jugular vein is drawn on one side or tied, as the case requires. The sterno-hyoid and sterno-thyroid muscles are divided as far as they are exposed. The third layer of the cervical fascia is now laid bare. An incision is made in this over the common carotid ; the artery is followed downwards with the finger until the origin of the subclavian can be felt and seen ; the internal jugular vein and the pneumogastric nerve are drawn to the outer side, and the anterior surface of the sheath cleared by gently separating the loose fat and the numerous thyroid and other veins lying in it. The pleura is pushed to the right ; the veins to the left, the sheath opened in between, and the needle passed from right to left.

A very great deal depends upon the length of the vessel. If possible there should be at least half an inch between the bifurcation and the ligature, and, to obtain this, part of the sternum and clavicle may be cut away if necessary. If there is not so much, the base of the carotid should be tied as well, but there is never sufficient of the subclavian. The operation has succeeded only once in eighteen times, secondary hæmorrhage having nearly always occurred from the distal end ; but possibly with more suitable animal ligatures of sufficient size and strength, better results may be obtained. Several patients lived for long periods, notably Thomson's, of Dublin.

Sédillot recommends a single longitudinal incision between the two heads of the sternomastoid, as enabling a better examination to be made of the bifurcation and the branches.

Ligature of the Common Carotid

The line of the artery, whatever the position of the head, runs from the sterno-clavicular articulation to the lobule of the ear. It extends from the joint as high as the upper border of the thyroid cartilage, and is crossed opposite the cricoid cartilage by the omo-hyoid. It may be tied at the root of the neck, below the omo-hyoid or above it. If a choice is allowed the point selected is at the upper border of the muscle.

1. *At the root of the neck.*—The position of the patient at first is the same as for ligature of the innominate. Afterwards the head is slightly raised and rotated to relax the sterno-mastoid muscle.

Either the angular incision may be used, or Sédillot's longitudinal one between the two heads of the muscle. The preliminary steps are the same as those described already, the sternal head of the sterno-mastoid being divided on a director if sufficient room cannot be obtained without. The sterno-hyoid and sterno-thyroid muscles are drawn inwards with a retractor or notched; the cervical fascia divided, great care being taken not to wound the numerous thyroid and other veins that lie beneath; and the sheath of the vessel exposed. This must be opened well to the inner side, and the needle passed from without inwards. On the right side the pneumogastric and the jugular recede somewhat from the artery, and they may be drawn still further away by applying a retractor to the clavicular part of the sterno-mastoid; on the left the vein may overlap it, and the thoracic duct lies immediately behind. The ligature should always be placed on the artery as far as possible from its origin; and this operation should not be selected unless, from the presence of aneurysm or from other cause, no choice is left. If it is attempted the artery will be found to lie much deeper than is generally expected.

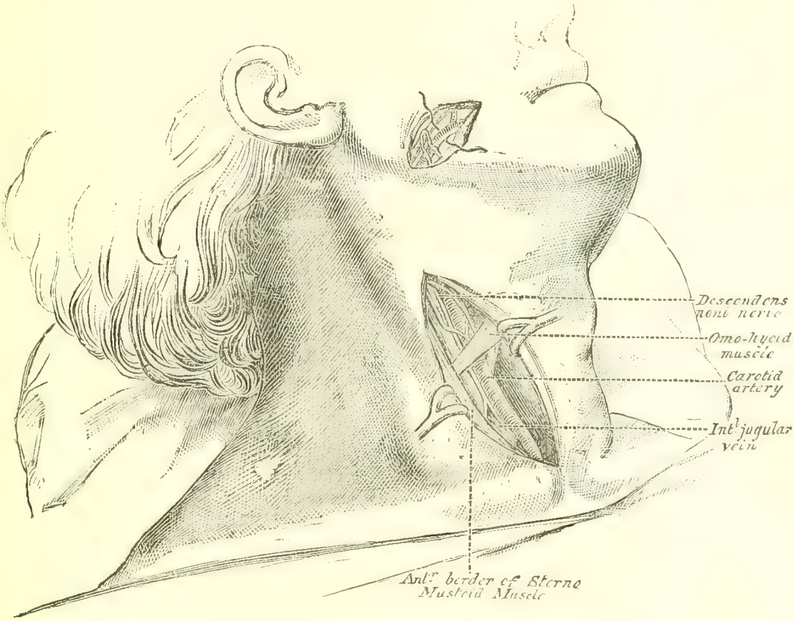


FIG. 47.—Ligature of the common carotid and facial arteries.

2. and 3. *Ligature immediately above or below the omo-hyoid muscle.*—The position of the patient is the same, the head being turned to the opposite side. An incision two inches and a half in length is made along the inner border of the sterno-mastoid: usually its centre lies opposite the cricoid car-

tilage, but it may be higher or lower as the case requires. The skin, superficial fascia and platysma are divided first; the deep fascia is slit up on a director, exposing the inner border of the sterno-mastoid, and avoiding if possible the sterno-mastoid artery, thyroid veins, and a communicating vein that often runs down along the inner border of the muscle from the facial to the anterior jugular. If this cannot be done the vessels must be tied. The head is now slightly raised, the sterno-mastoid drawn outwards, the sterno-hyoid and sterno-thyroid inwards; the deep fascia divided, and the omo-hyoid exposed lying upon the sheath, with usually some filaments of the descendens noni nerve. The sheath is opened on the inner side, avoiding the veins which often cross the upper part, and the needle introduced from without inwards.

This operation may be required for wound of the artery; for hæmorrhage from or aneurysm of either the trunk or any of the branches of the internal or external carotid; or as part of the distal operation for aneurysm of the innominate or the aorta. Owing to the effect upon the circulation through the brain, the two carotids should never be tied simultaneously; and if one is blocked the effect of temporary pressure should be tried upon the other before a permanent ligature is applied. Life has been maintained after both carotids and one vertebral have been obstructed; but on the other hand symptoms of cerebral anæmia have occasionally followed ligature of one, and not unfrequently that of both, even when the operations were performed with a considerable interval.

The common carotid can be compressed against the tubercle on the transverse process of the sixth cervical vertebra (the cricoid is opposite the fifth) by pressure backwards; or a little above this by grasping the artery between the finger and thumb, behind the sterno-mastoid when it is relaxed. Both are very painful and liable to cause syncope if kept up for more than a minute or two.

Ligature of the External Carotid

The line of the artery runs from the back of the thyroid cartilage almost directly upwards to the posterior part of the condyle of the lower jaw. The position of the patient is the same, with the face turned rather more to the opposite side.

An incision is made from behind the angle of the lower jaw to a short distance below the upper border of the thyroid cartilage, dividing the skin, superficial fascia and platysma, and watching carefully for the anterior division of the temporo-maxillary vein. This emerges from the lower border of the parotid and runs to join the facial, piercing the fascia either just below the gland or some little distance down. The anterior margin of the sterno-mastoid is then defined; its sheath laid open; and the deep fascia beneath carefully divided upon a director. The artery is usually tied opposite the cornu of the hyoid bone, the sheath being opened a little below and the needle passed from without inwards. Any veins that come in the way—thyroid, lingual, or facial—are either pulled on one side or tied with a double ligature and divided. If the temporal pulse is watched there is no fear of mistaking the trunk of the internal for that of the external, although it often lies more superficially at its origin.

The usual seat of ligature, at the level of the cornu of the hyoid bone, lies between the superior thyroid and lingual arteries. When, however, the object is to cut off the blood-supply from the middle meningeal or some other branch of the internal maxillary, the vessel may be secured immediately under the margin of the parotid.

Ligature of the external carotid is a very much more favourable operation than that of the common, partly because it avoids one of the great sources of collateral circulation and secondary hæmorrhage, partly because it does not interfere with the blood-supply of the brain. It should always be adopted in preference where it can be shown that one of its branches—the middle meningeal, for example—has been injured, or where this is exceedingly probable, as in stabs and other injuries in the region of the parotid. On the other hand, in punctured wounds of the tonsil, in cases of sloughing diphtheritic and scarlatinal ulcers, and when the seat of the injury is in the region of the greater cornu of the hyoid bone, where the internal carotid is more superficial than the external, ligature of the common trunk affords the better prospect, always provided that the bleeding point cannot be secured *in situ*. It must be remembered, with regard to injuries of the tonsil, that wounds of the ascending pharyngeal are no less fatal than those of the carotid ; when a small branch arises from a main trunk the pressure in it near its point of origin is scarcely less than that in the trunk itself.

Ligature of the Internal Carotid

This can be done through the same incision, the external carotid being drawn forwards and the internal jugular vein backwards. The needle is passed from without inwards. The operation has been performed in a fair number of cases with success.

Ligature of the Lingual Artery

The chief landmark is the greater cornu of the hyoid bone. The artery arises from the external carotid opposite this (when the body is in the position for ligature), and runs some little distance along its upper border. It may be tied either before or after it passes beneath the posterior belly of the digastric.

The head of the patient is thrown well back and turned towards the opposite side.

1. *Behind the digastric.*—The incision, two inches in length, starts from the margin of the sterno-mastoid, and runs slightly curving upwards immediately above the greater cornu. The skin, superficial fascia, and platysma are divided, watch being kept for the facial vein towards the posterior angle of the wound. If it is seen it must be pulled on one side. The projection of the submaxillary gland fills the upper portion of incision and overlaps the other structures ; the deep fascia is divided on a director along its lower border, the gland pushed up, out of the way, the tip of the greater cornu drawn down with a hook, and the posterior margin of the digastric defined. The angle between this and the upper margin of the hyoid is then carefully cleaned, the hypoglossal nerve pushed upwards, the ranine vein avoided, and the posterior fibres of the hyoglossus exposed. These are either divided on a director, pushing it between them and the middle constrictor; or by picking them up with a pair of forceps and cutting through them layer by layer. The artery lies with one, and sometimes two veins, close above the bone.

2. *After it has passed the digastric.*—The position is the same, but the incision starts half an inch below and external to the symphysis, runs downwards to the junction of the greater cornu and the body, and then turns upwards to a little below the angle of the jaw. The structures are divided in the same way, the submaxillary gland pushed up and a triangle exposed formed by the two bellies of the digastric and the hypoglossal nerve, dipping under the mylohyoid in front. The fat and loose cellular tissue which fill this space are removed, care being taken not to injure the ranine vein; the fibres of the hyoglossus, which form the floor, divided layer by layer; and the lingual artery, with its one or two veins, exposed, lying parallel to the upper border of the bone.

Ligature of the Facial Artery

This may be tied at the anterior border of the masseter, where it is only covered by skin, platysma, and fascia. A short transverse incision along the lower margin of the jaw is all that is required. The vein lies behind. It can easily be compressed in the same situation.

Ligature of the Temporal Artery

A short vertical incision immediately in front of the ear over the root of the zygoma is all that is required. The artery lies in some rather dense cellular tissue at this spot, with, as a rule, a single vein.

The occipital artery may require to be ligatured in the scalp, midway between the mastoid process and the external occipital protuberance; but in most cases, like the branches of the temporal, it can readily be controlled by pressure. In its deeper part, where it lies under the mastoid, it is almost inaccessible and is practically out of the reach of injury.

Ligature of the Subclavian Artery

The first part of the right subclavian has been tied fourteen times with a uniformly unsuccessful result, and, except in the case of some abnormality among its branches, it is difficult to see how it could be otherwise. The first part of the left is quite out of the question. On the other hand, ligature of the third part, on either side, is a very successful operation.

1. *Ligature of the first part of the right subclavian.*—The artery extends forwards, upwards and outwards from the bifurcation of the innominate behind the sterno-clavicular articulation.

The position of the patient and the line of the incision are the same as for ligature of the innominate; the inner border of the clavicular origin of the sterno-mastoid is divided as far as required, and the outer of the sterno-hyoid and sterno-thyroid, exposing the anterior jugular vein and the deep layer of the cervical fascia. The former is tied or pulled on one side, the latter divided very cautiously; the internal jugular vein with the vertebral, running down to join the innominate, drawn outwards; the innominate, if it rises too high, pressed downwards, and the connective tissue gently separated until the bifurcation of the innominate artery is exposed on one side and the origin of the vertebral on the other. The vagus should be recognised and pressed inwards towards the carotid, so as to avoid any injury to the recurrent laryngeal. If there is sufficient space between the origin of the vertebral and the point of bifurcation, the sheath is opened midway and the needle passed from below upwards and inwards, remembering that the artery rests upon the pleura behind as well as below; if the length is too short, the vertebral should be tied as well.

2. *Ligature of the third part of the subclavian.*—The patient lies on the back with the shoulders slightly raised, the head turned to the opposite side, and the arm drawn downwards to depress the clavicle as much as possible. The height to which the artery ascends above the clavicle is very variable, particularly on the right side; it may be almost concealed behind the bone, especially when the neck is short and the curves well marked; or it may rise an inch and a half above it. The pulsation can always be felt upon the first rib between the trapezius and the sterno-mastoid.

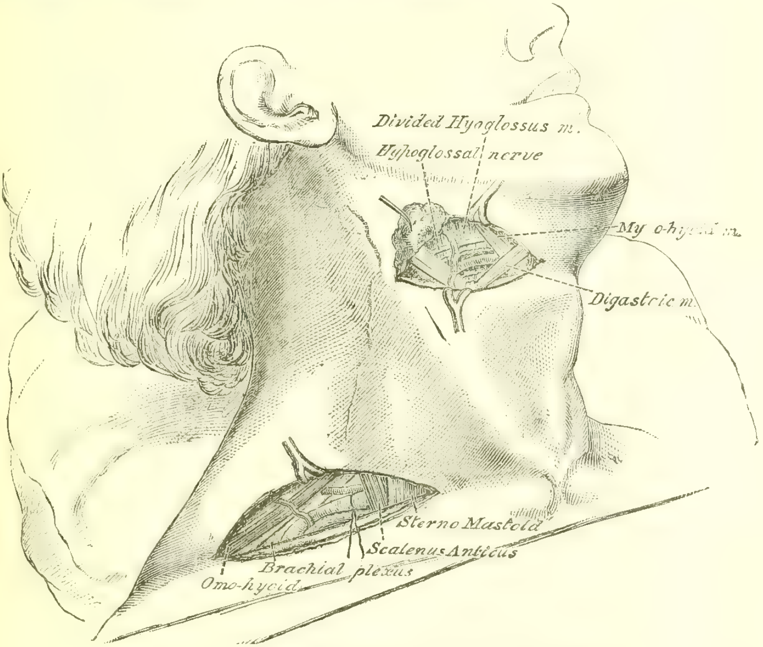


FIG. 48.—Ligature of Subclavian and Lingual Arteries.

The course of the external jugular vein should be ascertained first. sually it pierces the deep fascia an inch above the clavicle, just posterior o the sterno-mastoid. The incision, two inches and a half or three inches n length, is parallel to the clavicle, immediately above it, with its centre orresponding to the interval between the sterno-mastoid and trapezius; the in, superficial fascia, platysma, and descending branches of the cervical lexus are divided; there is no need to draw the skin down on to the bone. the external jugular vein is exposed it should be drawn to one side. he deep fascia is cut through upon a director, and if the interval between e muscles is very small, the edge of one or other or both may be notched. he space thus exposed is filled with loose cellular tissue containing a enous plexus formed by the terminations of the external jugular, supra-apular, and transverse cervical veins, a branch from the cephalic, and sometimes the anterior jugular as well. To avoid wounding these, the tissues must be carefully separated with a director behind the margin of the sterno-mastoid, until the edge of the scalenus anticus is felt with the finger. If this is traced down to the tubercle on the rib, the artery is made out at once, unless there is the rare abnormality in which it follows the course of the vein. As a rule, the sensation of the flattened band with rounded edges is characteristic, even if the pulsation cannot be felt. The chief difficulty arises with the lowest cord of the brachial plexus, but if care is taken to include only that structure which lies next to the scalene tubercle, and to feel the radial pulse before the ligature is tightened, it is scarcely likely to be mistaken.

The artery in this situation is surrounded by a dense funnel-shaped sheath prolonged from the cervical fascia ; this is opened by a small incision, and the needle passed from above, downwards, behind the artery, so as to avoid taking the lowest cord of the plexus.

The posterior belly of the omo-hyoid, the subclavian vein, and the transverse cervical artery are rarely seen. The supra-scapular branch may be in the way, running parallel to the clavicle, but it can always be drawn on one side. The third part of the artery is just free from the pleura. In many cases the posterior scapular or some other large branch arises almost from the spot at which the artery is usually tied ; if there is sufficient room the ligature is placed as far as possible on the distal side ; if there is not, the branch is tied as well. In some few cases, chiefly where the operation is done for aneurysm of the axillary, extending upwards under the clavicle, the outer margin of the scalenus anticus must be divided, and the second part ligatured. In doing this, care must be taken to avoid the pleura, which lies behind and below it ; the transverse cervical and supra-scapular arteries, which not unfrequently cross it ; and the phrenic nerve, which runs down upon the scalenus anticus, but usually leaves it just before it reaches the level of the artery. In any case, it is advisable to keep the line of division low down, but the position of the subclavian vein must be recollected.

The third part of the subclavian artery is easily compressed against the first rib, unless the neck is exceedingly short and thick. The operator stands behind the patient's shoulder and uses the thumb of the same hand (right, that is to say, for the right subclavian) pressing downwards, inwards, and backwards. If there is any difficulty, it is probably because the artery makes rather a higher curve than is expected. Sometimes a compressor is used, but the brachial plexus cannot then be so well avoided.

Ligature of the Vertebral Artery

This has been performed for secondary hæmorrhage after ligature of some of the larger trunks, and for epilepsy. The operation, however, so far as this last-mentioned affection is concerned, has been practically abandoned, although some of the cases derived considerable temporary benefit.

The position is on the back, with the head slightly turned to the opposite side. There is no line for the artery ; the guide to it is either the transverse process of the sixth cervical vertebra, or the interspace between the scalenus anticus and the longus colli.

The incision is three inches in length, down the posterior margin of the sterno-mastoid ; the external jugular vein must be avoided and drawn inwards with the muscle. The fascia beneath is carefully divided until the scalenus anticus, with the phrenic nerve and the transverse cervical artery, are recognised. Avoiding these, the inner border of the scalenus anticus is to be made out, and next to this, lying between it and the longus colli, is the artery. The transverse process of the sixth cervical is a further guide to the division if it is required. The vein lies almost always in front of the artery. Alexander, who has had the chief experience in this operation, recommends that it should be drawn inwards or outwards, whichever is most convenient, with an aneurysm-needle. Another needle is then passed from without inwards, behind the artery, threaded and withdrawn.

The pleura lies on the inner side of the wound, the subclavian artery below. If the vertebral enters the fifth foramen instead of the sixth it generally runs slightly more to the inner side.

Ligature of the Internal Mammary Artery

The internal mammary runs downwards behind the costal cartilages to he margin of the sternum in the sixth interspace, where it divides. At its rigin it is crossed by the phrenic nerve and by the junction of the internal ugular and subclavian veins; in the first three interspaces ligature is fairly asy; after that, it becomes more and more difficult. The incision is blique, with its centre corresponding to the middle of the intercostal space oncerned; the skin, superficial fascia, aponeurosis of the pectoralis major nd the intercostal fascia are successively divided and the artery exposed, vith a vein on either side. If there is not sufficient room, part of the costal artilages or of the sternum should be removed as well.

Ligature of the Axillary Artery

The axillary artery is tied either on the front of the thorax in the first art of its course, or from the axilla in the third. The line of the vessel, hen the arm is abducted from the side, is from the middle of the clavicle utwards to the inner side of the prominence caused by the coraco-rachialis.

1. *In the first part of its course.*—The patient is placed on the back with he shoulder unsupported, hanging over the edge of a pillow, and the arm by e side. Later, after the muscle is divided, a greater amount of space can e obtained by pushing the elbow somewhat upwards. Various incisions have een used, but the most simple is one running parallel to the clavicle, half n inch below it, from just inside the coracoid process to within an inch of he sternal end. The skin, superficial fascia, and some fibres of the platysma e divided; the clavicular portion of the pectoralis major is cut through in ccessive layers, any vessel that bleeds being clamped at once; and the sto-coracoid membrane exposed, with the cephalic vein crossing inwards d the acromio-thoracic artery (some branches of which have already been vided) coming forwards through it. The layer of fascia is cut through on director, parallel to the clavicle, above the perforation of the cephalic vein, d the axillary sheath exposed, covered with a little loose fat. The sheath opened well above; the vein lies almost in front of the artery, but it can ually be pressed down with the finger out of harm's way. The needle ould be passed from below upwards, avoiding the long thoracic nerve

which lies behind the artery on the serratus magnus, and the lowest cord of the brachial plexus which lies immediately above.

This operation can readily be performed upon the dead subject, but it is very doubtful if, in the living, it has any advantage over ligature of the third part of the subclavian; and certainly it has several grave disadvantages. Its branches are numerous, the vein is seriously in the way, very large abnormal branches not unfrequently arise from it, and the operation is much more difficult.

2. *In the third part of its course.*—The arm is abducted from the side and rotated outwards to bring the folds of the axilla, and the head of the bone into prominence. The line of the artery is parallel to the margins of the axilla, but nearer the anterior than the posterior. When operating on the left side, the surgeon stands between the arm and the thorax; on the right, it is more convenient for him to place himself on the outer side (fig. 49).

The incision, three inches in length, runs down the inner border of the coraco-brachialis from the highest point of the axilla. The skin and superficial fascia only are divided. The deep fascia is slit up on a director, the inner border of the muscle defined, the median nerve which lies next to it (except the musculo-cutaneous which perforates it) pulled slightly to the outer side, and the artery exposed behind it. The sheath is opened in front and the needle passed from within outwards.

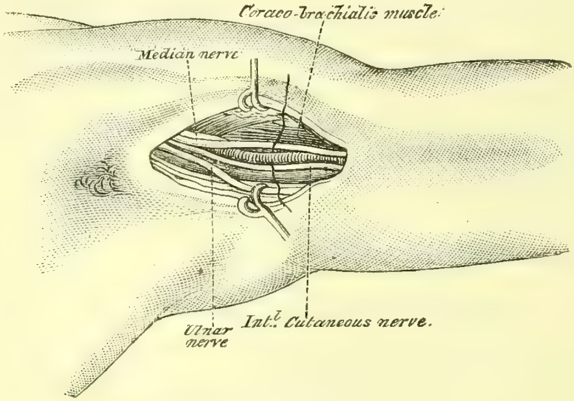


Fig. 49.—Ligature of axillary artery.

If the axillary vein is single and occupies the normal relation to the artery, it may not be seen at all or only indistinctly through the sheath; but often there are two, and sometimes they lie on opposite sides and are united by transverse branches across it. Abnormal branches are not at all uncommon, the radial, for example, arising high up.

Ligature of the Brachial Artery

The brachial artery may be tied in any part of its course. The line is from the inner margin of the coraco-brachialis in the axilla, down the inner margin of the biceps to the middle of the bend of the elbow.

The arm is abducted, extended, and rotated outwards. In the later steps f the operation, if the biceps overlaps the artery, the elbow may be flexed to relax it (fig. 50).

1. *In the upper and middle part of its course* an incision two inches long s made over the inner margin of the muscle, dividing the skin and the

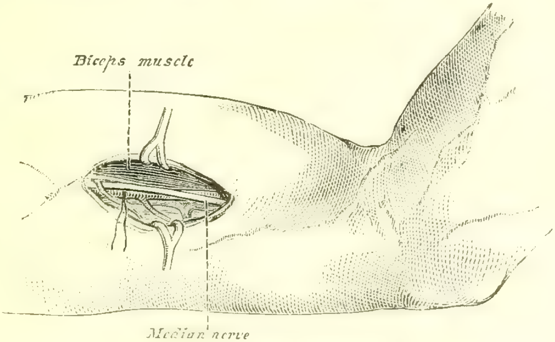


FIG. 50.—Ligature of brachial artery.

uperficial fascia only. The deep fascia is cut through upon a director, the uscle drawn outwards, and the median nerve which usually lies upon the nterior surface of the artery, drawn either outwards or inwards according its position. The artery lies to the inner side of the muscle, with a vein n either side of it; and the needle may be passed in either direction. ccasionally the median nerve lies on the deep surface of the vessel, not the uperficial, and sometimes a certain amount of difficulty arises from abnor-alities, the brachial winding round the internal condyle of the humerus, r dividing into two branches high up. It is said that a large inferior pro-unda has been mistaken for the artery, and that difficulty has been caused y the median nerve resting upon the vessel and receiving an impulse om it.

The brachial artery may be compressed against the shaft of the humerus any part of its course, the direction of the pressure varying with the part the artery concerned. In many cases it is rather painful, probably owing the fact that the nerves are pressed upon as well.

2. *Ligature at the bend of the elbow.*—The arm is abducted, the elbow

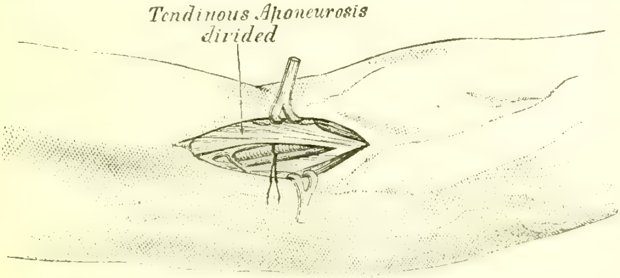


FIG. 51.—Ligature of brachial artery at the bend of the elbow.

tended and supinated. An incision an inch and a half in length is made liquely at the bend of the elbow, parallel and close to the inner border of tendon of the biceps, avoiding the median basilic vein, which lies to the inner side, and the median cephalic which lies below. As it is deepened the median basilic vein can be drawn inwards, and with it the internal cutaneous nerve. The strong semilunar fascia from the biceps is then divided upon a director, and the artery with its venæ comites exposed, lying surrounded by a small amount of cellular tissue and fat. The needle may be passed from either side, the median nerve being some little distance off (fig. 51).

Forced flexion and forced extension can control and even stop the pulsation in the brachial at the elbow, the former by compressing it between muscular masses, the latter by the tension exerted on it.

Ligature of the Radial Artery

The line of the vessel is almost straight from the inner side of the tendon of the biceps to just internal to the base of the styloid process of the radius; it may be tied in any part of its course (fig. 52).

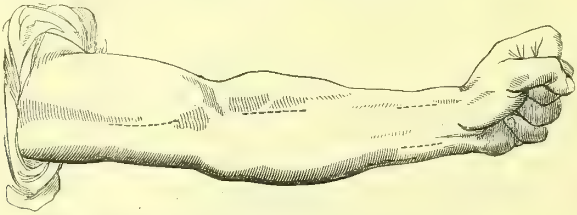


Fig. 52.—Line of incision for ligature.

The arm is extended and supinated; later, when the upper part of the artery is to be tied, the elbow-joint is flexed to relax the supinator longus.

1. *In the upper part.*—The line of the incision varies with the condition of the muscles. When they are only moderately developed it may correspond to that of the artery; but in cases in which the prominence of the supinato longus reaches beyond the middle of the limb, it is placed more to the inne side. The skin and superficial fascia are divided for from two to three inches, avoiding as far as possible the large cutaneous veins often present i the course of the vessel; the deep fascia is cut through upon a director, th

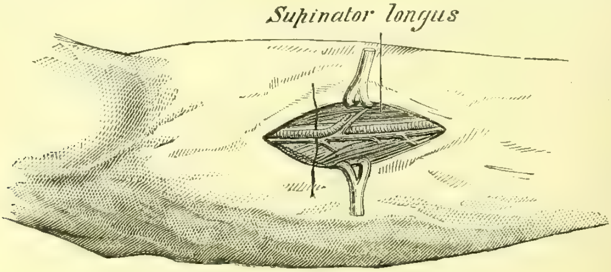


Fig. 53.—Ligature of radial artery.

edge of the muscle raised (while the elbow is flexed), and the under surfac followed until the artery is exposed, surrounded by a little loose fascia an lying upon the pronator radii teres. The veins lie on either side of it, tl nerve is not seen (fig. 53).

2. *At the wrist* this artery is quite superficial, and all that is required a very short incision on the radial side of the tendon of the flexor car

radialis, between it and the supinator longus. The deep fascia must be very cautiously cut through upon a director. Two veins accompany the artery ; the nerve lies adjacent to it for part of its course, but leaves it before it reaches the wrist (fig. 54).

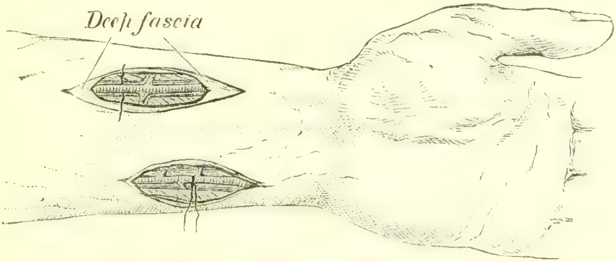


Fig. 54.—Ligature of the radial and ulnar arteries.

3. The radial artery may also be tied on the outer side of the wrist, vhere its pulsation can easily be felt. The hand should be adducted and lightly extended to relax the extensor tendons of the thumb.

Ligature of the Ulnar Artery

The line of the ulnar artery extends from the inner side of the biceps endon in the middle of the bend of the elbow, inwards to about the middle f the ulna, and then straight down to the outer side of the pisiform bone. he arm is extended and the forearm supinated ; but after the interval beween the muscles is found the wrist is flexed to relax the structures on the ont of the limb.

1. The artery can be tied in the upper third of its course, although it is ifficult to understand what circumstances could give rise to such an operaon. The line of incision is not that of the artery, it runs from the front of e internal condyle to the outer border of the pisiform bone, and is at ast three inches in length. The skin and superficial fascia are divided, and e deep fascia thoroughly exposed in order to find the white line that marks e tendinous edge of the flexor carpi ulnaris. This is divided for the whole ngth of the wound ; the hand is flexed to relax the muscle, and the fibres parated until the ulnar nerve is laid bare lying upon the flexor profundus. xternal to this is the edge of the flexor sublimis, which must be divided, d then carefully lifted up from the flexor profundus beneath, until the ssel is exposed with the veins on each side. Lower down, where it pproaches the nerve, it is much more easy.

2. At the wrist all that is required is a short incision along the radial le of the flexor carpi ulnaris tendon. As soon as this is exposed, the rist is flexed and the tendon raised with the handle of the scalpel, laying re the deep fascia which covers in the artery as it lies upon the flexor ofundus, or the annular ligament. The nerve lies to the inner side, and slightly deeper (fig. 54).

Ligature of the Abdominal Aorta

The abdominal aorta divides opposite the left side of the body of the fourth mbar vertebra, on a level with the umbilicus and the highest point of the est of the ilium. The line of the iliac arteries runs from this to a point on

Poupart's ligament, midway between the anterior superior spine of the ilium and the pubic symphysis. The upper third corresponds roughly to the common iliac, the lower two thirds to the external.

The abdominal aorta has been tied ten times in all, one patient surviving ten days after the operation. Cooper's incision was in the middle line of the abdomen, the intestines being pushed on one side and the peritoneum scratched through with the finger-nail. The other method is post-peritoneal, the incision being similar to that employed for ligature of the common iliac, but prolonged at least as high as the umbilicus. The needle should be passed from left to right.

Compression of the abdominal aorta is easily managed at the umbilicus by means of Lister's tourniquet, and may be kept up under an anæsthetic for an hour and more without any serious consequence. In thin people the artery may be controlled with the thumbs. The tourniquet should be placed upon the right side and with the upper pad rather beyond the middle line, as the aorta lies on the left.

Ligature of the Common Iliac

Abernethy's incision for ligature of the external iliac commences one inch above Poupart's ligament, half an inch outside the external abdominal ring, runs upwards curving round parallel to Poupart's ligament, and terminates a short distance above and internal to the anterior superior spine. How far it should be prolonged upwards in a case of ligature of the common iliac, depends upon the condition of the abdominal wall. Certainly it must be continued at least two inches above the anterior spine, and not unfrequently as high as the umbilicus (fig. 55). The skin and superficial fascia are divided first; then the external oblique, internal oblique, and transversalis muscle in order (some of the branches of the circumflex ilii being cut between the two last) and the transversalis fascia exposed. This can always be distinguished from the peritoneum by its being attached to Poupart's ligament. A small incision is carefully made in it, at the lower angle of the wound, where it is thickest, and where the sub-peritoneal fat collects most, and then it is divided for the whole

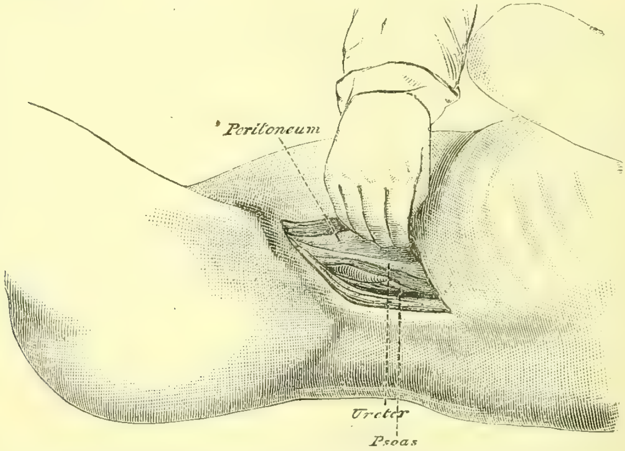


Fig. 55.—Incision for the application of a ligature to the aorta or common iliac artery.

length upon a broad flat director. The peritoneum is pushed inwards, not stripped up, the patient being turned over slightly to the opposite side; the sheath of the artery exposed and cleaned, and the needle passed round it from within outwards. The spermatic vessels and the ureter adhere to the peritoneum and so escape danger.

On the left side the veins do not give much trouble; the left common iliac lies to the inner side of the artery the whole way. On the right, however, the relation is much closer. The inferior vena cava begins on the right side of the artery, over the body of the fifth lumbar vertebra; the left common iliac passes behind the commencement; the right behind the end, winding round as it ascends until it comes to lie upon the outer side. As the artery cannot be seen the difficulty can easily be imagined.

The operation has been performed according to Lidell sixty-eight times with only sixteen recoveries, and it is a matter of question whether it would not be advisable to adopt Cooper's method—and especially if it is the right side—deliberately open the abdomen.

The common iliac arteries can be controlled at their point of bifurcation by means of Davy's lever. It is simply a smooth straight bar of wood which is introduced through the anus, and passed up the bowel until it rises out of the cavity of the true pelvis. By raising the outer end and turning it to one side or the other, the opposite artery is easily compressed against the bone, just at or above its bifurcation. It controls the branches of the internal as well as of the external iliac, but it is in many cases very difficult of introduction; when a large loose rectum falls into folds it is sometimes no easy matter for the hand to find its way up; perforation has been caused by it, and the mucous membrane of the bowel is liable to slough if the pressure is continued.

LIGATURE OF THE INTERNAL ILIAC

The position of the patient and the line of the incision are the same as for ligature of the common trunk. The peritoneum must be pushed inwards in the same way, and the finger passed down over the external branch to find the internal. The needle is passed from within outwards, the internal iliac vein lying behind it and to its inner side, the termination of the external and the commencement of the common behind, and to the outer side at its origin. There is usually a little more than an inch available.

LIGATURE OF THE GLUTÆAL ARTERY.

The line of the glutæal artery extends from the posterior superior spine of he ilium to the apex of the great trochanter; it emerges from the pelvis at he junction of the upper with the middle third. The position of the patient s face downwards with the thigh extended.

The incision is in the line of the artery, four inches in length. The skin nd superficial fascia are divided, the fibres of the glutæus maximus exposed nd separated, and the upper margin of the great sacrosciatic foramen felt for with the finger. The artery emerges through this between the margins of he pyriformis and the glutæus medius.

The spot at which the sciatic artery is found lies internal to and below his, in the middle of the line drawn from the posterior superior spine to the uberosity; the incision is vertical.

The internal pudic lies about half an inch internal to this, under the cover of the great sacrosciatic ligament.

LIGATURE OF THE EXTERNAL ILIAC

The line of the artery is the continuation of that for the common iliac; exceptionally in old people with tortuous vessels it is thrown into curves, the most marked of which usually dips down into the pelvis. The position of the patient is the same, the limb being extended and slightly abducted.

There are two methods: Abernethy's, which has been described already, and Cooper's (fig. 56). The incision in the latter is slightly concave upwards, about half an inch above Poupart's ligament, commencing to the inner side of the centre, and running towards the anterior superior spine for about three inches. The skin, superficial fascia, and a few small vessels passing over Poupart's ligament are divided; the aponeurosis of the external oblique is incised for the same distance upon a director; the internal oblique and transversalis muscle drawn upwards and outwards, or if necessary divided to a slight extent, and the transversalis fascia with the internal abdominal ring and the spermatic cord exposed. The deep epigastric artery and the cord are then pulled upwards and inwards, the transversalis fascia cautiously divided

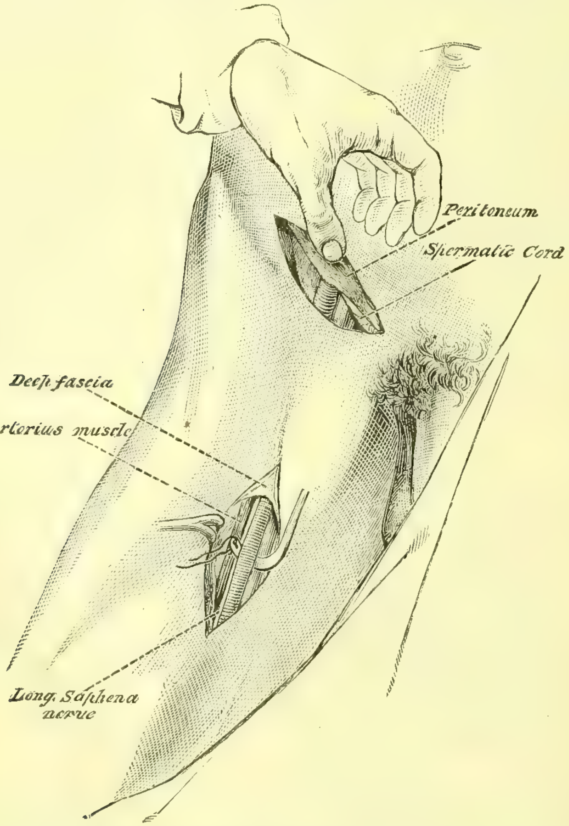


FIG. 56.—Ligature of external iliac and superficial femoral arteries. In this figure the incision for the femoral artery is placed too low.

sufficiently to admit the finger, and the sheath of the artery exposed, overlapped to a very slight extent by the peritoneum. The needle is passed from the side of the vein, taking care not to include the genito-crural nerve.

Cooper's operation there is no doubt interferes with the strength of the abdominal wall less than Abernethy's, although, if buried sutures are used, and the layers carefully united to each other in their proper order, it suffers very slightly in either. The peritoneum is less exposed, and perhaps is in less danger of being injured, but the difference is not a material one. The deep epigastric, on the other hand, is distinctly in very great danger and has been wounded; the circumflex ilii vein almost crosses the seat of ligature, and if the lower part of the artery is diseased, it is impossible to reach the upper, much less the common iliac, without enlarging the wound very seriously. Abernethy's therefore is to be preferred for all cases except aneurysms situated below Poupart's ligament in which the artery can be shown to be healthy where it crosses the pubes.

Ligature of the Femoral Artery

The line of the artery begins at the mid-point between the pubic symphysis and the anterior superior spine, and when the limb is straight runs down to the inner border of the patella, the vessel extending two-thirds of the distance. If, on the other hand, the limb is flexed, abducted and rotated outwards—the position in which it is placed for operation—the lower point is the adductor tubercle on the internal condyle (fig. 57).

The common femoral is tied immediately below Poupart's ligament, the superficial one either at the apex of Scarpa's triangle or in Hunter's canal.

1. *The common femoral.*—The incision may be either longitudinal or transverse. The former is two inches in length in the line of the artery, beginning immediately below Poupart's ligament; the latter is parallel to the ligament, half an inch below it, and across the vessel. The skin, superficial fascia and fascia lata are very carefully divided in either case; the sheath of the vessel exposed, avoiding the genito-crural nerve, and the compartment that contains the artery opened on the inner side. The needle is passed from within outwards about half an inch below the ligament.

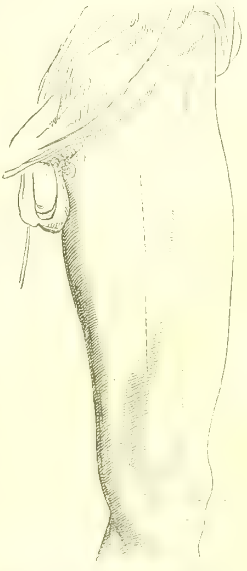


Fig. 57.—Line of incision for ligature of the femoral artery.

The objections urged against this operation are the uncertain length of the artery; the origin of the profunda is usually an inch and a half below Poupart's ligament, but it may be very much higher or very much lower, and then one of the large circumflex branches frequently comes off from the main trunk by itself; and the fact that this part is frequently diseased. But in carefully selected cases it has been shown to be very successful.

The common femoral is easily controlled by digital or instrumental compression where it passes under the ligament, resting upon the bone.

2. *The superficial femoral in Scarpa's triangle.*—The point selected is at the apex, just before it is crossed by the sartorius, usually four or five inches below the ligament and two or three below the origin of the profunda.

The limb is slightly flexed, abducted and laid upon its outer side, the line of the artery marked out (if possible the pulsation should be felt) and the course of the internal saphena vein ascertained. The incision is three inches in length, with its centre opposite the point selected. The skin and superficial fascia are divided; the fascia lata exposed, and the edge of the sartorius made out as it runs downwards and inwards past the lower margin of the wound. The fascia is divided along the edge of the muscle, which is then drawn outwards and raised with a retractor; another thinner layer cut through beneath, and the sheath of the vessel exposed, with perhaps the internal cutaneous nerve crossing it. A small opening is made in the sheath and the needle passed round the artery from within outwards, care being taken not to injure the vein which lies almost immediately behind.

3. *The superficial femoral in Hunter's canal.*—Hunter's canal occupies the middle third of the thigh measured upon the inner side; the point selected for ligature is in the middle of this or midway between the groin and the knee. The line of the incision, when the limb is flexed, abducted, and rotated outwards, is a finger's breadth internal to the line of the artery, and should be three or four inches in length.

The skin and superficial fascia are divided, avoiding the internal saphena vein, and exposing the fascia lata covering the sartorius. The muscle is recognised by the almost vertical direction of the fibres. The fascia is divided upon a director along its outer or anterior border, the muscle pulled inwards with a retractor, and the fibrous tissue forming the roof of Hunter's canal and stretching from the vastus internus to the adductors exposed. The aponeurosis is slit up on a director, some branches of the anastomotica perhaps being divided at the inferior angle; the sheath of the vessel exposed, with the long saphenous nerve lying upon it just before it perforates the adductor magnus; a small opening made in it and the needle passed from without inwards, the vein lying to the outer side and slightly behind.

Ligature of the Popliteal Artery

The popliteal extends from the opening in the adductor magnus to the level of the tubercle of the tibia. It may be tied in the upper or in the lower part of its course.

1. *In the upper part.*—The position of the limb is the same as for ligature of the femoral in Hunter's canal, with the knee flexed. The operator stands on the outer side. An incision three inches in length is made immediately behind the tendon of the adductor magnus, commencing or ending, as the case may be, opposite the adductor tubercle. The skin and superficial fascia are divided, taking care not to cut the internal saphena vein; and the fascia lata separated from the anterior margin of the sartorius, some of the branches of the anastomotica probably requiring to be twisted or clamped. The adductor tendon is drawn forwards, the sartorius and the inner hamstrings backwards (the long saphenous nerve will probably follow the adductor tendon, and with it the main superficial branch of the anastomotica); and search made with the finger and a director in the fat that

protrudes. The depth of the artery varies according to the distance down the limb; the vein is not seen at all.

2. *In the lower part.*—The patient lies upon the face or in what is known as the three-quarter prone position, with the knee at first extended. Afterwards it may be bent to relax the gastrocnemius if it is required. The incision is vertical, three inches in length in the line of the vessel and outside the external saphena vein if this is seen. The skin, superficial fascia, and deep fascia are divided successively; the internal popliteal nerve pulled outwards, the semi-membranous inwards if it is exposed, and the dissection carried very carefully through the loose fat that fills the space. The separation from the vein, which lies superficial to the artery and rather to the outside, is often very difficult, and great care must be taken not to mistake one for the other, as the coats of the vein are unusually thick and rigid for its size. The needle should be passed from without inwards.

LIGATURE OF THE POSTERIOR TIBIAL

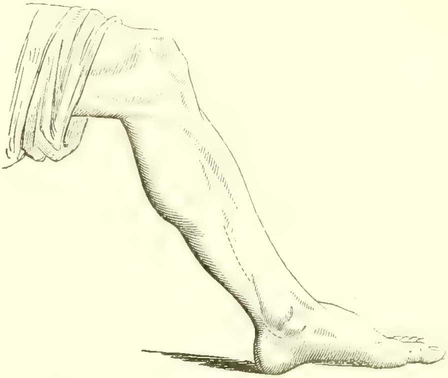


FIG. 58.—Lines of incision for ligature of the posterior tibial artery.

The line extends from the middle of the knee-joint to midway between the internal malleolus and the projection of the heel, commencing at the lower border of the popliteus muscle, just below the level of the tubercle of the tibia. It may be tied in the middle of the leg, low down, or behind the internal malleolus (fig. 58).

1. *In the upper part.*—The patient lies on the back with the knee well flexed and laid on its outer side. The incision is four inches in length, parallel to the inner border of the tibia three-quarters of an inch behind, and exactly in the middle of the leg. The internal saphena must be avoided. The skin, superficial and deep fasciæ are divided; the gastrocnemius pulled to one

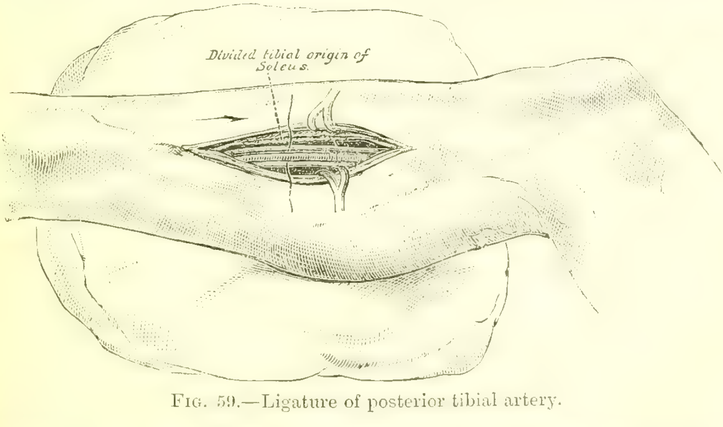


FIG. 59.—Ligature of posterior tibial artery.

side; the tibial origin of the soleus cut through in the same line until the glistening tendinous layer on the deep surface and the fibres that arise from it are recognised; and the superficial muscles pulled away from the deeper ones. Between them there is a sheet of fascia, anterior to which are the vessels resting upon the tibialis posticus. There is a vein on either side, while the nerve at this point usually rests upon the artery (fig. 59).

2. *In the lower part.*—The position of the foot and the patient is the same. The incision is much shorter, mid-way between the border of the tibia and the tendo Achillis. The deep fascia, which has been prolonged down from the interspace between the muscles, is stouter here than it is above. The nerve lies more to the inner side.

3. *Behind the internal malleolus.*—A short curved incision two inches in length is made behind and below the internal malleolus, the pulsation of the vessel being the best guide. The deep fascia here is thicker still, forming the internal annular ligament that binds the tendons down. Care should be taken not to open any of the synovial sheaths (fig. 60).

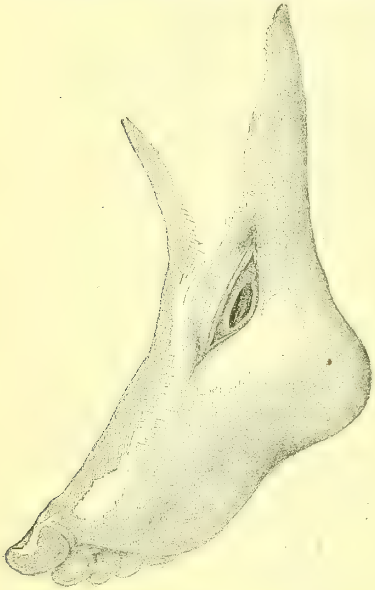


Fig. 60.—Ligature of the posterior tibial artery behind the internal malleolus.

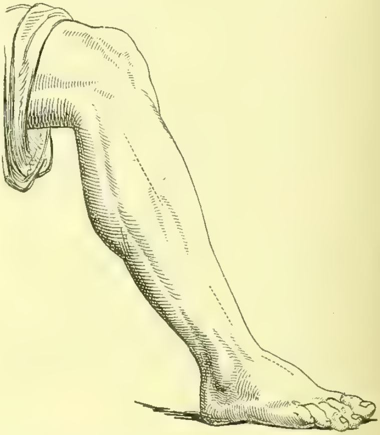


Fig. 61.—Line of incision for ligature of the anterior tibial.

Ligature of the Anterior Tibial

The artery extends from a point mid-way between the head of the fibula and the external tuberosity of the tibia to another which lies mid-way between the two malleoli, and from thence to the base of the space between the two first metatarsal bones. At first it is very deep: lower down its pulsation can be easily felt. The leg is extended and the foot held in the position of the plantar flexion (fig. 61).

1. *In the upper third.*—An incision from three to four inches in length is made in the line of the artery and deepened until the deep fascia is reached. If the separation between the extensor communis digitorum and the tibialis anticus cannot be seen when the foot is bent upwards, a transverse or oblique cut is made through the aponeurosis. The line of division

then is usually evident at once. The two muscles are separated with the handle of a scalpel, and the artery is found lying with the nerve superficial to it and a vein on each side.

2. *In the lower part of the leg.*—The incision is three inches in length in the line of the artery. The skin and superficial fascia are divided, and careful search made with the finger for the gap between the extensor hallucis and the common extensor. If this is found the aponeurosis is slit up on a director, and search made under the former of the two; even a short distance above the ankle-joint the tendon often has not yet crossed to the inner side. If there is no indication the fascia is slit up in the same way, and all the structures that lie on the inner side pulled outwards away from the tibia with the forefinger; the innermost cord, which consists of the tibialis anticus and the extensor hallucis, is now allowed to slip back and search made for the vessel next to it. The nerve lies upon the outer side (fig. 62).

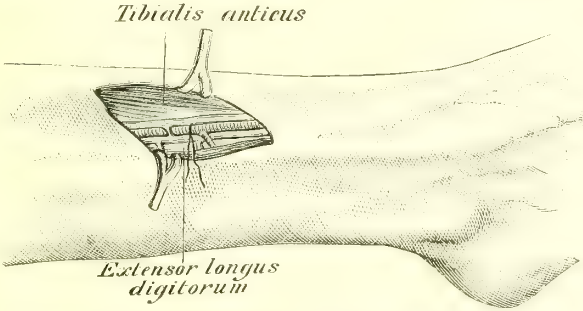


FIG. 62.—Ligature of the anterior tibial artery.

3. *The dorsalis pedis.*—The guide to the artery is the inner slip of the extensor brevis digitorum. The incision is made over this in the line of the vessel, the tendon drawn to one side and search made beneath (fig. 63).

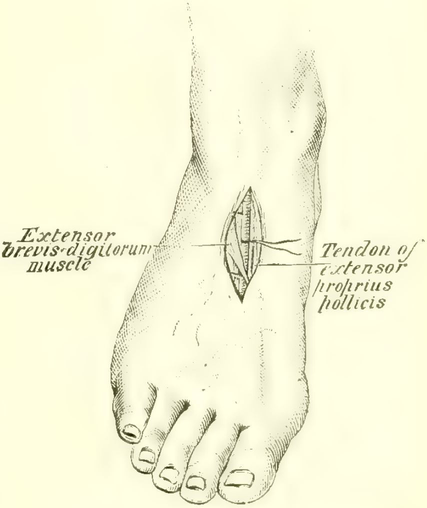

Extensor brevis digitorum muscle
Tendon of extensor proprius hollicis

FIG. 63.—Ligature of dorsalis pedis artery.

CHAPTER III

INJURIES AND DISEASES OF THE LYMPHATICS

INJURIES OF LYMPHATICS

The lymphatics are so widely distributed that they must be severed or torn in every cut or bruise to a greater or less extent; but as a rule they collapse at once, and give no trouble. Persistent escape or collection of lymph, unless there is some obstruction higher up, causing œdema of the part, is very rare; but probably a great deal of the early discharge from wounds comes from the divided lymphatics, and certainly the poisons that cause the various kinds of wound fever (septic and traumatic), are chiefly absorbed through them.

The thoracic duct has occasionally been wounded, leading to the discharge through a fistulous opening of a spontaneously coagulating liquid, milky during digestion; and in one case its opening is stated to have healed under a plug. In another instance the duct was ruptured opposite a fracture of the spine, and the contents were poured out into the pleural cavity, compressing the lung and ultimately causing death.

DISEASES OF LYMPHATICS

LYMPHANGITIS

Acute inflammation of the lymphatic vessels is always secondary, and is usually caused by the entrance of an irritant poison through the connective-tissue rootlets. Exceptionally it follows sprains, or the inflammation spreads from surrounding structures and involves the wall directly. In most cases the immediate source is a poisoned wound, often a mere pin-prick or scratch, sometimes so small that it is overlooked altogether; and consequently it is of frequent occurrence among butchers, cooks, and those engaged in post-mortem work. In the case of the throat it may perhaps originate without an abrasion, the poison entering through the spaces between the epithelial cells; but naturally this is incapable of proof. Recent wounds are much more likely to be attacked than granulating ones, and those which are not kept at rest or in which there is any discharge confined under high tension, and above all, pustules, are the most likely of all.

Whatever the irritant may be, it probably does not cause inflammation of the wall of the vessel unless it is arrested by clotting. If this does not take place, it is hurried on to the neighbouring lymphatic glands, and sets up inflammation there.

Pathology.—The changes are best seen in the larger trunks. The delicate cellular tissue that surrounds the vessel and forms its outer wall is swollen, softened, and congested; the intima becomes cloudy, the endothelial plates lose their distinctness of outline, and the lymph that fills the vessel and the plasma that circulates through and around its walls coagulate. They are no longer in contact with healthy structures. Outside the vessel altogether, some distance away from the irritant, the blood-vessels dilate, and the blood and the plasma circulate more rapidly and in greater quantity; immediately around the exciting cause, the stream either ceases or is carried on very slowly, and the lumen of the vessel, the interstices in its walls, and its cellular sheath become filled with a coagulating exudation.

The future course, whether resolution, organisation, or suppuration sets in, depends upon the cause. Resolution begins at once, if the irritant is slight and transient; the fibrin disappears, the walls of the vessel recover, the endothelium is regenerated, and the circulation is re-established. Organisation is probable, if its action is persistent, as in syphilis; and the coats of the vessels, and the cellular-tissue in which they lie, become hard, dense, and sclerosed. Suppuration only takes place when pyogenic micro-organisms are the exciting cause, coagulation-necrosis setting in, and the solid tissues becoming liquefied and melting away. As a rule, it is circumscribed, but if the tissues are badly nourished from intemperance or starvation, or if there is septic decomposition as well to assist, it may be diffuse and boundless.

Symptoms.—These are plainest when the superficial vessels are involved. Red lines mark out their course upon the skin—wavy, irregular, very tender to the touch, slightly raised above the surface, and hardened from thrombosis. Sometimes they are quite narrow; sometimes, when the poison is very active, an inch or more in breadth. At the same time the glands are swollen and tender, and if the affection is extensive the limb below may be œdematous. With the deeper trunks most of these signs naturally are wanting; but usually, even in the deepest, faintly outlined patches of redness are visible here and there upon the skin, where the superficial plexuses communicate with the deep ones.

A rigor is not uncommon at the beginning, and if the inflammation is widely spread there may be a very considerable degree of fever and prostration. Simple lymphangitis is rarely serious; if, however, suppuration sets in it may be attended by very grave illness, and if the vessels (which run in groups) are extensively destroyed, a condition of solid œdema is very likely to persist, leaving the limb more or less crippled. When it occurs as part of a diffuse inflammation of the cellular tissue its significance is of course altogether different; it is part then of a general suppurative infection, not unlikely to end in pyæmia, the chief safeguard against the constitutional affection spreading through the lymphatics being the arrest of the pyogenic micrococci in the neighbouring glands.

Treatment.—The cause should be removed at once or rendered innocuous by the free use of antiseptics; tension immediately relieved by incision, drainage, warmth, or other measures, as the case requires; absolute rest enforced; and the limb raised to diminish the amount of blood entering it as well as to facilitate the return of the lymph. Cold evaporating lead lotion is the best local application. Quinine may be given internally if the temperature is high; and the bowels usually require to be opened.

If suppuration occurs the abscess should be incised at once. Afterwards, when the inflammation has subsided and the wound healed, if there is any œdema left it may be relieved, if not cured, by the proper application of massage and bandaging.

LYMPHADENITIS

Inflammation of lymphatic glands always accompanies inflammation of the vessels; but in a very much larger number of instances it occurs independently of them, the irritant having been carried along by the lymph stream without causing any symptoms until arrested in the gland. It may be *simple* (*acute*, ending in resolution or suppuration, and *chronic*) or *specific*, as in tubercle, syphilis, glanders, and perhaps some chancroids.

I. *Simple Adenitis or Bubo*

The pathological changes are similar to those that occur in inflammation elsewhere. The cortex is the part first involved: it becomes more vascular, soft, and swollen; the lymph-paths are filled; the corpuscles are packed in the follicles as tightly as they can be; the reticulum loses its distinctness; and here and there, where stasis occurs and the capillaries give way, masses of red blood-corpuscles can be seen. In recent acute cases the gland is a deep purple throughout, and the connective tissue around is swollen and infiltrated with lymph almost to the same extent. This may terminate in *resolution*; or the inflammation may become *chronic*; or *suppuration* may occur.

a. Resolution.—The process is exceedingly simple; the hyperæmia diminishes; the excess of lymph-corpuscles is gradually removed; the lymph-paths are opened up again; old extravasations are quietly absorbed; and the whole gland resumes, or nearly so, its normal condition. A certain degree of enlargement is very commonly left, especially if the attack is repeated.

b. Chronic inflammation.—This termination is almost as common. The cellular exudation, instead of being absorbed or undergoing fatty degeneration, becomes organised; the capsule is thickened, hard, and adherent to the structures round; the adenoid tissue of the follicles is indurated; and occasionally, when the glands are extensively involved, the circulation is seriously impeded, leading to dilatation of the lymphatics and even solid œdema in the parts below.

c. Suppuration.—This may begin either in the gland itself, yellow foci of coagulation-necrosis occurring in the various parts of the cortex and enlarging until they fuse; or more generally as periadenitis. In the latter case, when the abscess is opened, the gland is found lying in a more or less sloughing condition, attached to one side of the cavity. Residual abscesses are of common occurrence in connection with lymphatic glands; inflammation subsiding and remaining quiet perhaps for years, and then, from some slight additional irritant, suddenly breaking out again and running on to suppuration.

Causes.—A moderately acute form of inflammation not unfrequently follows over-exertion or exposure to cold, especially if there has been at any time a previous attack. The glands become swollen and painful; the skin over them is tender on pressure; the neighbouring muscles are stiff, and movement is much restricted. As a rule, this subsides without any serious result as soon as the cause ceases to act; its importance is due to the fact that the tissues, enfeebled by inflammation, form a most suitable soil for the development of any germs that may reach them. Suppuration may occur, especially in those whose health is broken down; tubercular disease may follow; I have known it to develop rapidly in the femoral glands after a strain in jumping; and in children it is probable this often happens. The eruption of the teeth, for example, is attended with a considerable degree of enlargement and some inflammation of the submaxillary glands. In most cases this subsides of itself as soon as the parts become quiet again, but occasionally it forms the starting-point for suppuration or tubercular disease, the micrococci or bacilli, as the case may be, gaining access to the damaged tissues through the mucous membrane of the mouth. When the glands are healthy these germs are practically inert.

Acute inflammation of the glands arises from the same causes as acute lymphangitis, especially poisoned wounds in which there is friction or ension to facilitate absorption. In rare cases it is said that there is no reach of surface, but it is proverbially impossible to prove a negative. Specific forms of inflammation can only arise from specific causes, and these re rarely limited to the gland first involved; tubercle, syphilis, glanders, c., all tend to spread from one to another, although there may be at first a emporary arrest. This is not so with the micrococci of suppuration. Against hese the adenoid tissue seems to possess an unusual power of resistance; ot only does the mischief rarely extend beyond the glands first attacked, ut these themselves appear capable of holding out for an exceptionally long eriod. Inflamed glands are exceedingly common as the result of gonorrhœa, oft sores, pustules, poisoned wounds, and many other injuries; but, although f course many instances do occur, suppuration is by no means invariable. The yogenic micrococci must be carried to the glands in abundance by the lymph orpuscles and the lymph stream; but if the adenoid tissue is fairly well ourished, and protected from injury, in many cases they are only able to xcite a certain degree of inflammation.

Chronic adenitis, if not of specific origin, usually results from the frequent petition of acute attacks. The glands are left slightly enlarged, hardened, d infiltrated with fibrous tissue; and they may persist in this condition ithout change and without causing any symptoms for years. In many stances, it is impossible to say how far this is due to syphilis.

Symptoms.—When the attack is acute, and the gland is tightly bound wn by fascia, the symptoms are severe. On the other hand, if there is a rge amount of loose cellular tissue around, so that there is but little tension, ey may be very slight; in the axilla even suppuration may occur without e patient complaining of it. Pain, heat and swelling are the most promint; the first especially, when the deeper glands are involved; the last en the structures round are soft and yielding. Tenderness on pressure is ays present; and if the gland can be felt, it is fixed in its bed, partly m its size, partly from the cellular exudation around binding it down. e constitutional disturbance, like the pain, depends largely upon the sion; in the slighter cases it is scarcely noticeable; in the more acute es, especially when the deep glands are inflamed, it is often very marked.

Suppuration may begin very quietly when the tissues around are loose and lding; or there may be high fever and even a rigor. The part begins to ob, the skin is red, glazed and œdematous; the swelling rapidly increases size, and the outline becomes ill-defined. If the pus forms in the interior, tuation is often very indistinct; if around the gland, it may be apparent ost at once.

There is rarely any difficulty in the diagnosis of acute inflammation; the locality, the nodular character of the swelling, and the evidence of an exciting cause (which may, however, have already disappeared) indicate at once the structure concerned. Chronic enlargement is more difficult, especially in the groin, where it is easily mistaken for epiplocele and *vice versâ*. The shape of the swelling, the direction it takes, and the fact that it is rarely single, but nearly always involves the neighbouring glands, are the most important distinctions. The question of suppuration is very different; in a large proportion of cases it is practically impossible to say, without exploration, whether it has commenced or not.

Treatment.—The exciting cause should, if possible, be removed at once. Absolute rest, cold, uniform compression and elevation are the most effectual measures for preventing suppuration; heat and counter-irritants only encourage it. When pus forms, the shortest way is to open up the abscess freely, allow the contents to escape of themselves, and apply boracic fomentations with a considerable degree of pressure, in order to keep the surfaces at rest. If the gland has been destroyed and remains adherent to the inner surface of the abscess, it should be removed at the time of the operation. In the groin, if the redness and œdema are very well defined, showing that there is not much infiltration of the cellular tissue round, two punctures with a drainage-tube or a bundle of horse-hair passed across may succeed, and in very slight cases even a single one; but unless the patient is kept in bed with such an amount of dressing on that the limb is practically fixed, it is very likely to end in the formation of a chronic sinus.

II. *Tubercular Adenitis*

The lymphatic glands are one of the most common seats of tubercular disease. The bacilli enter through the mucous membrane of the respiratory or alimentary canal, or through the skin (after wounds, abrasions, attacks of eczema and the like), and at once, if there is the least predisposition, or if the resistance of the tissues is lowered by inflammation, lead to the deposit of miliary tubercle. In a few cases infection may take place through the blood. No glands in the body are exempt; but naturally those in certain localities—the neck, the mesentery, and the mediastina—are more often affected than others; and it may occur at any age, although it is by far the most common in children and during young adult life.

Pathology.—The changes are characteristic; grey miliary nodules develop, usually in the centre of the adenoid masses, with typical giant and epithelioid cells; and outside these an infiltration of smaller ones, lying in a zone of hyperæmia; and caseation soon begins in the middle. Several of these small nodules form near each other and fuse, so that when the gland is cut across there is a dead white caseous spot surrounded by a soft pinkish grey areola. Gradually, as these increase and multiply, fresh tubercles forming round their margin, the whole gland becomes enlarged; the capsule grows thicker, partly from the irritation and tension to which it is subjected, partly from the condensation on it of the loose cellular tissue around; and at length, if it is cut across when the disease is advanced, the only trace of normal adenoid tissue left is a thin layer immediately under the capsule; the whole of the rest is converted into a dense white caseous mass, many times the size of the original gland, but still showing its origin by its shape

The subsequent changes are the same as those that occur elsewhere. If the tubercle-bacilli spread and the whole gland becomes involved, the central portion breaks down into a greenish-yellow puriform fluid; the surrounding cellular tissue is invaded through the hilum, and suppuration follows, forming an irregularly-shaped abscess (often extending long distances under the fascia) with the remains of a lymphatic gland, consisting chiefly of the capsule lined with caseating tubercle, still adherent to one part of the wall. If, on the other hand, they perish, either calcification or fibroid induration, or both together, follow.

Symptoms.—The characteristic feature is a chronic, painless enlargement, affecting usually several glands in the same locality, although often one more than the rest. At first they are freely movable, but, after a time, they become matted together and adherent to the surrounding structures. Later, after a very variable period, softening may occur; the swelling enlarges in size and becomes more ill-defined; the skin becomes reddened at one point, grows thinner and thinner, and finally gives way, leading to the discharge of a thin oily pus, mixed with caseous débris, and leaving a sinus which nearly always pursues a most irregular and devious course. Healing, if these cases are left to themselves, is always very protracted; the growth of the tubercle must cease, the whole of the caseous material come away, and the sinus close from the bottom; and as the skin is usually undermined in all directions, and it is exceedingly difficult to keep the parts at rest, it may be many years before it is complete.

General infection from superficial caseating glands is rare, although it may take place from the mediastinal ones. Local recurrence again and again is not uncommon; but at length, in the vast majority of cases, the patient lives down the bacillus and recovers, bearing the traces of his illness in the deep seams and cicatrices left.

Treatment.—The constitutional treatment of tubercular adenitis is of the greatest importance; sea air, tonics, cod-liver oil, good feeding and careful protection against cold, exposure, and irritants of all kinds. In many instances the balance between caseation and liquefaction on the one hand, and absorption and organisation on the other, turns entirely upon this.

The local treatment depends largely upon the amount of inflammation present and the number of glands involved. If there are only two or three and they are perfectly quiet and painless, without any evidence of adhesion to the tissues round them, they should be left altogether alone, or the skin may be thickly covered over with Ung. plumbi iodidi and oiled silk at night. Rubbing and counter-irritants, such as tincture of iodine, are only too likely to precipitate an acute attack. If in spite of this the enlargement continues to increase, or signs of softening or of inflammatory adhesion begin to appear, excision may be performed, provided there is a reasonable hope of removing the whole; either caseation has taken place already in spite of all that has een done to check it, or it will very shortly, and undoubtedly the best and nost effectual method, when the disease is limited and superficial, is free emoval. It leaves a linear cicatrix in a situation chosen because it is con-ealed, and the wound is sound within a week, in place of a sinus that may ontinue to discharge for years, and invariably causes a depressed, seamed, nd irregular scar. Even when the skin is involved the same plan may be ried with success. It must always be remembered, however, that the real umber of the glands concerned is probably far in excess of the apparent, and that removing the more superficial ones is very likely to expose many more that lie deeper. The operator therefore must always be prepared, as unless the whole affected area is cleared little good is likely to result. Even such extreme measures as division of the sterno-mastoid and dissecting out the great vessels and nerves of the neck have been recommended.

If softening and suppuration have already taken place the actual cautery may be used to perforate the inflamed structures and destroy the interior of the gland; or it may be freely incised, the interior thoroughly scraped out with Volkmann's spoon, and packed with iodoform. Unhappily, in most cases the number of glands involved precludes anything like radical treatment of this kind; and all that can be done is to open any abscesses that are pointing; slit up, or enlarge and drain any devious sinuses running beneath the fascia; scrape out all the caseous débris that is accessible; and try by means of constitutional treatment to improve the general health, so that cicatrisation may take place.

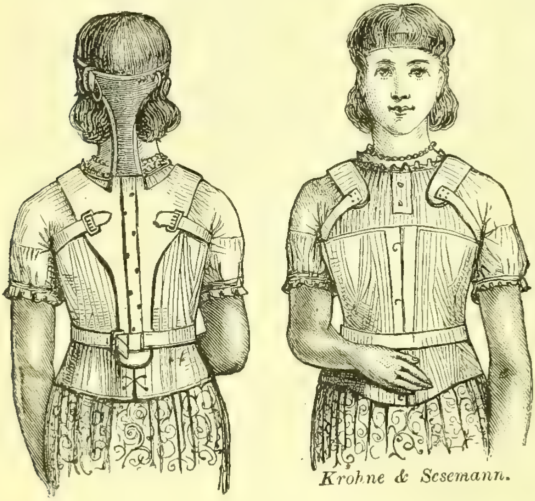

Krohne & Sesemann.

FIG. 64.—Treves' cervical splint.

It not uncommonly happens in the neck that chronic sinuses with purple overhanging edges are left for years, similar to those met with in the groin. In many cases these can only be cured by cutting away all the overhanging tissue, scraping out the interior, thoroughly stimulating the base, and making the route direct. Hilton, however, has shown what it is possible to do to these by the judicious application of trusses in the groin; that the chief reason of failure of union is the perpetual motion to which the part is subjected; and that repair can take place, even in advanced cases, if absolute rest is enforced; and Treves has strongly advocated the same thing in the neck. There is no doubt that, although the presence of caseous gland tissue and the indirect burrowing under the fascia have much to do with the delayed union and unsightly cicatrices so common after tubercular adenitis, want of rest is almost if not quite as important; and in every case in which this cannot be ensured in other ways some appliance, such as Treves' splint or a gutta-percha stock, should be used after operations.

LYMPHATIC GLANDULAR TUMOURS

All forms of carcinoma and many of sarcoma involve the lymphatic glands sooner or later; these, however, are secondary growths, and derive their significance entirely from the primary one elsewhere. In addition there are others which originate in the glands themselves.

Primary lymphatic glandular tumours form an exceedingly difficult group; it is impossible to classify them satisfactorily either by their pathological structure or their clinical history. Microscopical examination fails to show any definite distinction between normal gland tissue, inflammatory hypertrophy, simple tumours, or malignant ones; and clinical symptoms are no more successful, at any rate in the earlier stages when the diagnosis is of importance. Certain varieties that are fairly well characterised can be described; the rest must be grouped round them, nearer or farther away, according to the sum of the features they present.

I. *Lymphoma*

This name is given to a perfectly simple form of overgrowth affecting one or at the most two or three glands in one part of the body. As such it is decidedly rare (fig. 65).

No cause is known; the gland steadily but persistently increases in size without undergoing the least change in structure. It is not inflamed or painful: it does not contract adhesions to the parts around; it does not degenerate or decay in any way; and it is not attended with any form of cachexia. On section it is absolutely normal, or at the most slightly lighter in colour than the other glands. It may attain a fair size, and cause considerable annoyance, but it is seldom very large.

Lymphatic glandular tumours answering this description are certainly exceptional. In the vast majority of instances, if they are excised (the only treatment suitable for them) and divided in two, it is found either that they contain a caseous focus in the middle, or that without any change visible to the naked eye, they are full of miliary tubercles; in other words, that they are really examples of tubercular adenitis, which from some unknown cause, possibly an unusual power of resistance on the part of the patient, have followed an unusual course; the tubercles have continued to increase, but the lymphatic tissue has increased at a faster rate, without sufficient inflammation to make the capsule contract adhesions. In other cases it is probable that they are really the beginning of lymphadenoma, for sometimes, if they are left, they suddenly change their character and begin to grow rapidly.

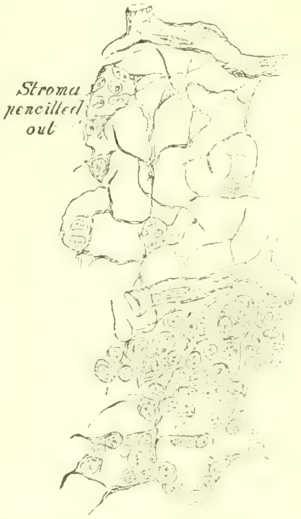


Fig. 65.—Lymphoma, from the cervical glands.

II. *Lymphadenoma*

Two forms of this are described by some, according to whether leukhæmia is present or not; but, as it is impossible to say upon what this depends, why it should occur in one case and not in another, it does not seem a sufficient reason for separating them. It is sometimes known as Hodgkin's disease or malignant lymphoma.

The pathological changes that occur in the glands in the earlier stages are identical with those met with in lymphoma or in chronic inflammation.

In some instances the adenoid tissue is in excess and the glands are soft and juicy; in others there is a larger amount of fibrous tissue, the size is smaller and the consistence firmer. The difference, however, does not appear to be anything more than a physical one; clinically the two forms are precisely alike.

Lymphadenoma, at its commencement, may be confined to the lymphatic glands; or it may occur in the spleen before the glands are involved; and deposits of adenoid tissue, which however may be secondary, are not uncommonly found in the alimentary canal, the liver, kidneys, the medulla of bone, and elsewhere. It is evidently therefore a disease of an entirely different character from true lymphoma; but when it is primarily glandular, it may be impossible to distinguish one from the other, until, by the appearance of secondary growths, it is too late. Nothing is known with regard to its etiology; it is most common in young adult life, and in the cervical region; but it may begin in the inguinal, or axillary, or even, though rarely, in some of the internal glands.

The growth is more rapid than that of lymphoma, sometimes so rapid as to cause a certain degree of tenderness from the stretching of the fascia around. Gland after gland is involved, and instead of remaining isolated from each other, they become matted together into smooth, bossy, prominent tumours, which however remain for some time encapsuled. In this condition they may last unchanged for several years, or they may even diminish in size, although they very rarely disappear; but at any moment they may suddenly begin to grow again, spread into the cellular tissue that surrounds them, forming enormous masses from which all trace of the original glands is lost, and start in other parts of the body as well. When this takes place the end, as a rule, is not far off. The patient's health begins to fail, emaciation is rapid, sometimes hectic and profuse night-sweats occur, the appetite is lost, diarrhœa or epistaxis sets in, dropsy makes its appearance, and the sufferer usually dies of exhaustion. In other cases the trachea or œsophagus is compressed, even the action of the heart may be interfered with; masses in the abdomen may cause jaundice, and towards the end more or less leukhæmia, though not sufficient in every case to give a distinct white tinge to the blood, is a very usual feature.

Instances are sometimes met with in which the whole of the tissues of the neck seem to be involved. The skin is red, as if inflamed, soft, and almost fluctuating, and from the head to the thorax is simply a gigantic, shapeless, mass of adenoid tissue, growing rapidly, exceedingly vascular, and enclosing the blood-vessels, nerves, and all the important structures of the part.

III. *Sarcoma*

Lymphatic glands are occasionally the seat of an intensely malignant form of sarcoma, round-celled, spindle-celled, or lymphoid. It differs from lymphadenoma in the extreme rapidity of its growth, in the fact that (until quite late in the course of the disease) only one tumour is formed, that it remains limited for a much longer time to one set of glands, that it tends to invade the skin and all the structures round, and that it is not accompanied by leukhæmia. Sometimes it is so soft and attended with such a degree of pyrexia that it may be mistaken for an abscess, and I have known it, springing from the mediastinal glands, displace the heart and lungs, cause pressure upon the recurrent laryngeal and other nerves, and from its extreme vascularity pulsate so forcibly as to raise the suspicion of an aneurysm.

Treatment.—The treatment of lymphatic glandular tumours is very unsatisfactory, chiefly on account of the great difficulty of diagnosis in the earlier stages. Simple lymphoma, if it does not rapidly subside under tonics and cod-liver oil, should be excised, whether it is true lymphoma or a caseous gland (as it usually is), or the beginning of lymphadenoma; only, as already mentioned in tubercular adenitis, the operator must be prepared to remove the whole, and often it is much more extensive than it appears to be.

Lymphadenoma, if it has once passed this stage, is better left alone; complete removal is practically hopeless; no sooner is one mass taken away than another appears beneath, more difficult of access still; and the presence of leukhæmia is an absolute bar to any surgical operation not of imperative necessity—such, for instance, as tracheotomy: the hæmorrhage is uncontrollable.

Arsenic, with iron and cod-liver oil, is of undoubted value in many cases, although unfortunately the improvement is rarely permanent. It is usually given in the form of Fowler's solution after meals, and the dose must be increased by about a minim a week until the patient can take no more; other drugs do not seem to have any effect, and no local application of any kind is of any use.

LYMPHANGEIECTASIS AND LYMPHANGEIOMA

The lymphatics are liable to dilatation and distension in the same way as the capillaries and veins. Sometimes this is congenital, like nævus, sometimes it is caused by obstruction. The minor form, affecting especially the smaller vessels, is known as lymphangeiectasis, the more pronounced as lymphangeioma.

I. *Congenital dilatation*

This may appear under various shapes. In the simplest there is merely an irregular expansion of the lymphatic vessels, generally in the skin, forming ampullæ and cavities of various sizes, lined with the characteristic endothelium. In those that are more severe the dilatation is greater, the partition walls between the cavities are thinner so that they break down, and enormous, irregularly branching spaces are formed, sometimes spreading among the deeper structures to a distance of which the outside appearance gives no conception.

The most exaggerated form of this *cavernous lymphangeioma* is known as *hydrocele of the neck*, *congenital cystic tumour*, or simply *hygroma*. It may be present at birth, or it may be so small that at that time it does not attract attention, and then later, when it begins to enlarge, it may be mistaken for an acquired growth. The most common situation for it is the neck, but it may occur in the axilla or the back, or even in the region of the kidney. Sometimes it is apparently a single cyst, extending an enormous distance under the fascia; more frequently it is polycystic with cavities of all sizes, in some of which the fluid is clear and watery, in others greenish, and in others again distinctly and perhaps deeply blood-stained. The favourite locality is the posterior triangle of the neck, or just behind the angle of the aw, whence they may extend into the mouth; over to the opposite side of the body in front or behind the trachea; down into the thorax, or in short almost everywhere. The walls vary in strength, though never very thick.

Occasionally they contain here and there portions of nævoid tissue, which can be detected when superficial by the bluish tint they give. Much more rarely there is a considerable amount of solid growth, so as even to give rise to the suggestion of sarcoma (fig. 66).

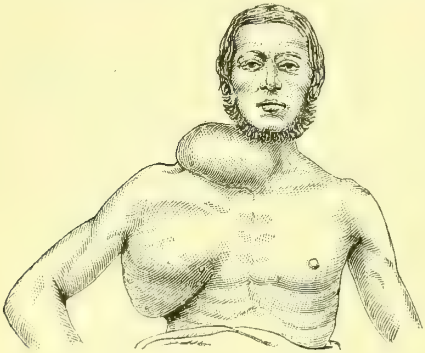


Fig. 66.—Serous cyst of the neck. (Birkett's case.)

A similar pathological condition probably underlies macroglossia, macrocheilia, and some at least of the varieties of congenital overgrowth of the limbs. Whether the enlargement of the breasts, which, though not congenital, sometimes develops at puberty, is to be attributed to the same cause is uncertain. It appears at least to affect only the cellular-tissue elements of the gland, not the secreting structure.

The treatment of any of these congenital affections requires to be carried out very circumspectly. Single cysts may be tapped, and, if they refill, injected with iodine or with Morton's fluid. Larger ones may be drained, or a seton passed through them, but it must be remembered that very often they have very deep connections, and that if suppuration occurs the fever that follows is likely to prove exceedingly serious or even fatal. Polycystic growths may be drained seriatim, a deeper part being opened only when the superficial has contracted to a sinus. Excision is rarely practicable.

In cases of congenital giant growth, if the size is excessive, or if sarcomata develop from the imperfectly organised tissues, as sometimes occurs later in life, amputation is the only resource. Macroglossia and macrocheilia, when they are small, can sometimes be kept in check by astringents, but usually inflammatory hypertrophy is added to the congenital form, and the only hope is partial excision.

II. *Obstructive dilatation*

Long-continued obstruction to the lymphatics causes a certain degree of varicosity similar to that which occurs in the veins, only much more rarely, because of the greater freedom of anastomosis. Sometimes the smaller vessels are affected most, so that the superficial parts, skin or mucous membrane as the case may be, are channelled in all directions by a *reticular* network, which may even raise up the epidermis in the form of minute vesicles; sometimes the larger ones, *tubular lymphangeiectasis*. The same thing occurs in connection with the veins, but in neither is the reason for the difference obvious. After a time, the condition known as *solid œdema* follows: the part becomes hard and brawny; the skin and the subcutaneous tissue are thickened and indurated; an enormous growth of lowly organised connective tissue takes place throughout the limb; the muscles waste; the veins are compressed, making matters worse; the part becomes so heavy and stiff that the patient can hardly use it; and at length it develops into a state practically identical with *elephantiasis*. At first the outline is smooth, uniform, and rounded; but after a time local inflammation occurs from some trivial cause, owing to the poor nutrition of the part; and then it becomes irregular and nodulated all over. Finally, in some cases, rupture of the lymphatics takes place ; a thin clear fluid, coagulating more or less perfectly, continues to drain away (*lymphorrhœa*) ; the patient's health fails ; and the continued moisture of the part leads to an eczematous condition of the skin, which again in its turn makes the inflammation worse.

Causes.—Obstruction may be due to various causes, and according to the part of the body affected, leads to very various results.

The simplest variety is that which follows repeated attacks of erysipelas (infective capillary lymphangitis). If this recurs often, partly from the obstruction to the lymphatic vessels, partly perhaps from the chronic induration of the glands, the skin remains permanently thickened, and when the face is concerned a very serious degree of disfigurement is left.

In phlegmasia alba dolens, the form of white leg that occurs so commonly after pregnancy, it is probable that the veins are involved as well as the lymphatics, sometimes one, sometimes the other being the worst. It is rarely serious, although it often assists in the production of chronic ulcers of the leg ; but I have known it, when frequently repeated, end in the most enormous nodular enlargement of the whole limb (except the foot) and ead to very serious lymphorrhœa from an opening in Scarpa's triangle.

Cancerous enlargement of the lymphatic glands in the axilla leads to the same condition in a very short space of time. The axillary vein may be igatured and cut away with impunity ; there will scarcely be even transient edema ; but when the cancerous growth involves the glands, the hand and arm enlarge to such an extent that the patient is unable to lift the limb from the bed.

The presence of parasites, especially the filaria sanguinis hominis, produces even a more striking series of symptoms. The parent worm usually resides in one of the larger central lymphatics, and from this locality discharges into the stream myriads of ova or embryos. Some of the main channels become obstructed by the inflammation that takes place around them ; dilatation sets in, and in many cases rupture follows, most frequently into the bladder (probably because of the very variable degree of support the mucous membrane receives), causing chyluria ; but occasionally nto the cavity of the tunica vaginalis (chylous hydrocele) ; and sometimes ven externally. The same thing has been known to occur from the pres-ure of tumours, and from other causes leading to obstruction of the thoracic duct.

It is probable that the disease known as *Elephantiasis Arabum* really riginates in the same way. Essentially it is a chronic hypertrophy of the kin and the subcutaneous tissue, usually of the leg or the scrotum, causing normous enlargement and deformity, and resulting from repeated attacks f inflammation ; but though thus far it resembles the worst cases of solid edema, it differs considerably in other respects, especially in the peculiar orm of fever and the acute inflammatory attacks that accompany it.

The fever is of a remittent type and is known locally as elephantoid. ometimes it is exceedingly severe, and attended with great pain ; more ften it is only moderate in degree and as the disease advances tends to die ut. The intervals between the attacks may be as long as a month ; with ach there is an outbreak of acute inflammation, the limb becoming tense nd hot ; the skin reddened, and even covered over with vesicles as in ery-ipelas. In a few days the symptoms subside, but the limb never regains its former size; and one attack follows another until the condition becomes hopeless. In the early stages the skin is but little affected; later it becomes pigmented, covered with eczema, ulcerated, scarred, roughened, and nodulated in proportion to the severity of the local inflammation.

The legs and the external genitals are the parts most often affected; the scrotum in particular, from the looseness of its natural texture and the ease with which it borrows skin from the abdomen, may be enlarged, so that it sweeps upon the ground. Very often enormous hydroceles, or dilatations of the lymphatics (varix) and lymphorrhœa are associated with it.

Treatment.—Much can be done to relieve the symptoms in the milder cases of lymphatic obstruction, even when the cause is beyond control: rest in an elevated position; massage, bandaging, support when the limb hangs down; and, according to some, the constant current (the positive pole always nearest the sound parts) often effect material improvement in a very short space of time. Cancerous obstruction, however, of the axilla, and obstructions to the abdominal lymphatics and lacteals rarely admit even of relief.

Elephantiasis in its milder forms should be treated in the same way. Rest, pressure, and elevation succeed best during the acute stage, combined with suitable constitutional measures. Afterwards either support and pressure must be used, Martin's elastic bandage being of especial service; or, if the mass is such as to disable the patient, it must be removed, by amputation in the case of the leg (it rarely extends far up the thigh) or incision if it is the scrotum. In either case, the part should be well bandaged and elevated first, in order to reduce the amount of blood it contains as much as possible, and careful examination made so that no hernia is overlooked.

An attempt should always be made to dissect out the penis from the enormously hypertrophied prepuce; and sometimes at least the testes can be preserved, their position being easily ascertained by the amount of the hydrocele fluid that surrounds them.

Ligature of the main artery of the limb has been practised with temporary alleviation; possibly compression deserves a further trial.

CHAPTER IV

INJURIES AND DISEASES OF NERVES

INJURIES

NERVES may be divided, wholly or in part; torn across, or torn out of the pinal cord; bruised from external violence; or compressed against some re- isting structure. The immediate effect is an interference with the conduct- ng power of greater or less extent and duration, according to the kind of njury sustained.

I. WOUNDS OF NERVES

Pathological changes following division.—A nerve that is cut across begins o degenerate at once. The whole of the peripheral part is involved simul- neously: the myelin runs into cylindrical masses which become granular nd fatty, and at last disappear. The axis-cylinders split up into fibrils and isintegrate, so that they can scarcely be recognised at the end of a week; nd the nuclei of the sheath increase in size and begin to multiply. In two three weeks the whole of the peripheral segment is atrophied. The central nd changes in a similar manner, but only for the distance of one or two odes; above this it remains practically unaltered, it may be for years.

The subsequent course depends upon the proximity of the two ends, and pon the possibility of union taking place between them.

(*a*) *When they are in apposition and the wound heals by the first inten- n.*—Union takes place by what is known as nerve-callus, vascular granu- ion-tissue developed from the nuclei of the sheath and perineurium as ll as from the ordinary sources. In animals newly formed axis-cylinders ow from these nuclei, connecting one end with the other, within three or r days. In man this has not been proved; but in all probability the ne mode of union does occur, though rather more slowly, as occasionally, en placed under very favourable conditions, the conducting power of a ided nerve returns within a few days. Such a result, however, is eptional; immediate suture, even when apposition is accurate, usually uires weeks.

(*b*) *When the ends are not in apposition.*—The changes that follow are re complex and depend largely upon the distance between.

Bowlby has described a process of spontaneous regeneration as taking ce in the distal segment six or seven months after section. The nuclei he sheath increase in number, become spindle-shaped, range themselves ows in the spaces of the perineurium, and gradually transform themselves fibrils round which a myelin sheath develops. How far this takes e in all cases, even whether it occurs in all, is uncertain. That it must erially assist the restoration of function in the case of secondary union re can be no question.

Repair may occur when there is an inch between the ends; and a few cases are recorded in which even greater distances than this have been bridged: but they are few and far between; and the restoration of function in most of them is very imperfect, even after a long period of time has elapsed. As a rule only a fibrous band is found, sometimes not that.

If union fails, the regeneration of the distal segment dies away again; permanent degeneration sets in, and the nerve is reduced to a small fibrous cord, the structure of which can still be recognised on cross section owing to the peculiar nature of the perineurium. The central end may remain almost unchanged, or grow out into a rounded expansion of variable size—a nerve-bulb. These are met with chiefly in amputation-stumps, but they may occur anywhere; they consist for the most part of fibrous tissue; but in the end nearest the nerve-trunk a considerable production of new nerve-fibres takes place, although their size is small and there is only a limited amount of myelin round them.

In very old cases atrophic changes are met with in the spinal cord as well, affecting especially the intermedio-lateral column on that side, the posterior very little.

Symptoms.—The immediate symptoms are due to interruption in the function of the nerve; the remote ones are the pathological lesions that follow.

1. *Immediate.*—Loss of sensation over the region supplied by the nerve is definite, provided it is complete. On the other hand, persistence of sensation does not in any way negative division. Very little, scarcely anything indeed, is known about nerve-anastomosis, either the coarse blending that can be shown by dissection, or the finer union that probably takes place in the nerve plexuses; and there are many instances in which nerves have been divided, and have even had pieces excised from them, without leaving the expected area of anæsthesia. A considerable length of the musculo-spiral for example has been excised without any loss of sensation corresponding to the radial. Further, in many cases the area of anæsthesia, if time is allowed to elapse, very often becomes smaller, as if collateral branches grew in all round the margin. The sensation that persists after nerve-section is sometimes almost perfect: more frequently localisation is inexact, especially at first; and occasionally analgesia occurs without anæsthesia.

In any case of suspected injury the examination must be made with the greatest care. The patient should be blindfolded; the part well supported, so that there is no communicated vibration; and various kinds of stimuli used, thermic for instance as well as tactile. In no case may a conclusion be drawn either as to the non-division of a nerve, or its union after suture, without taking into consideration other effects as well as loss of sensation.

Loss of muscular power is equally definite, provided it continues and is followed by other signs, such as rapid wasting and disappearance of faradic excitability. Temporary paralysis may occur from shock, contusion or compression, and be indistinguishable for two or three days. The atrophy is of the most extreme kind; the fibres lose their striation, degenerate and shrink; the nuclei multiply; the interstitial connective tissue increases, until in a very short time the whole muscular substance disappears, and nothing is left but a rigid inextensible mass of fibrous tissue. Faradic excitability disappears very soon; there is often a distinct diminution by the third day; galvanic on the other hand, continues longer, but rarely or never, according to Bowlby shows the increase that usually occurs after nerve-section in animals; and the anodal closure contraction precedes or occurs as soon as the cathodal.

2. *Later changes.*—In addition to the muscular wasting, the joints, the skin and the connective tissues exhibit after a time very distinct alterations. The cartilages undergo fibroid degeneration, the capsule and the connective tissue round shrink and grow hard and rigid, the joints become stiff, fibrous ankylosis sets in, and osseous union has been known to follow. The skin becomes smooth and glossy. If the hand is involved the fingers assume a peculiar tapering shape, the hairs fall off, the natural wrinkles and folds disappear, and the colour becomes a pinkish red. Sometimes, especially when the weather is cold, there is a constant burning pain—causalgia. Vesicular and bullous eruptions, herpes, subcuticular whitlow, and ulceration are not uncommon. In rarer cases the end of the finger is slowly eaten away, or dry gangrene sets in and involves the whole anæsthetic area. The nails are often affected; they may be short, stunted, and fibrous, or curved either across or longitudinally, so that their edges and angles bite deeply into the flesh. The connective tissue disappears, the secretion of sweat ceases, and generally (after the first few days at least) the temperature of the part falls one or two degrees. In exceptional instances it has been known to continue higher than that of the corresponding part on the opposite side of the body.

These changes are noted more or less regularly after section of any nerve, though, owing to the frequency with which the ulnar and median are divided at the wrist and the musculo-spiral damaged in the arm, they are more commonly seen in connection with the hand than in all the other parts of the body put together. Other affections, however, are occasionally met with of a more special character.

Perforating ulcer of the foot is the most common and in some respects the most striking. It occurs chiefly in connection with locomotor ataxy and the chronic form of nerve-degeneration that is associated with it; but it is also met with in the anæsthetic form of leprosy, after fracture of the spine with partial paralysis, and after degeneration of the nerves without the spinal cord being affected at all. In most cases it is situated on the ball of the great toe, but it may occur on the outer side of the tread or in any part. A corn forms irst; after a time the epidermis in the centre softens and breaks down; and an opening is left in the middle, which at first sight appears altogether insignificant, but if a probe is passed into it, it is usually found to extend far into the substance of the foot, and not unfrequently to involve the bone or the metaarso-phalangeal articulation. There is little or no pain, the edges of the ore are usually whitened and callous, and in many cases the skin around it s entirely anæsthetic. Not unfrequently it is present on both feet at the ame time.

In the majority of cases perforating ulcer heals readily as soon as the foot s raised, protected from injury, and kept warm. Very often it breaks out gain if the part is used. The nutrition of the tissues is so enfeebled that, hough they can repair the effects of an injury when very favourably placed, hey are unable to withstand the slightest pressure or irritation.

How far these changes are due to lesions of trophic nerves, and how far hey are simply the result of malnutrition from disuse, is undetermined. In ny case injury plays an important part in causing them. Sensation is lost, he immediate effect of any violence is unperceived, and fresh injury inflicted efore the first has a chance of getting well. Ulceration and gangrene of the fingers, for example, which attain their climax in anæsthetic leprosy, and perforating ulcer of the foot are directly excited by injury, although they would not occur without the nutrition of the part being defective; the point at issue is whether this arises simply from disuse and anæsthesia, from the interruption of trophic nerves or from their irritation.

There is no evidence that partial division of a nerve is followed by trophic or inflammatory disturbances more frequently than complete section. On the other hand, when it does occur, the consequences are limited to the distribution of the divided fibres, and they follow regardless of the manner in which the interruption is effected, whether by section, rupture, compression or chronic inflammation, provided only it lasts a sufficient length of time.

II. Subcutaneous Injuries of Nerves

Contusion.—Section of a nerve is followed by the most characteristic consequences, other injuries differ according to their severity. If, for example, the force of the blow is only slight the conductive power of the nerve is suspended for the moment, there is a certain amount of dull aching at the injured spot, tingling is felt at the periphery, and often there is a subjective sense of heat, with at times actual flushing. When the injury is more severe and the nerves are badly crushed, loss of sensation and of muscular power may be complete and followed by wasting and disappearance of the faradic excitability over the whole area supplied. As a rule the prognosis in these cases is good, or at least better than in section, because the physical continuity is not destroyed, and although trophic lesions may follow they usually disappear again of themselves, but occasionally they persist. Some of the worst cases occur in connection with the upper cords of the brachial plexus, one or all of them being crushed in falls upon the shoulders, and leaving paralysis, perhaps permanent, of a corresponding portion of the arm. When, on the other hand, the plexus is torn out from the cord (as when a man in falling from a height catches hold of something in the hope of saving himself) the lower cords suffer most and with them the sympathetic of the eye, leading to narrowing of the palpebral fissure and permanent contraction of the pupil.

The diagnosis of the extent of the damage sustained in subcutaneous injuries is very difficult. If the faradic excitability of the muscles persists, the hurt is probably slight. If it rapidly disappears and this is followed by wasting and the reaction of degeneration, there is no doubt that the physiological continuity of some of the nerve-fibres is interrupted, and if the whole of the muscles supplied by the trunk are affected in this way it is highly probable that the nerve itself is torn across.

Compression.—The same symptoms are caused by gradual compression, whether this is due to the growth of a tumour (a cervical exostosis, for instance, pressing on the brachial plexus), the enlargement of an aneurysm, the growth of callus, the contraction of a cicatrix, or some external agent. Paralysis of the musculo-spiral is not uncommonly caused by a person going to sleep with the arm hanging over the back of a chair, the nerve in this particular position being caught, almost unprotected, between the wood and the bone. When the cause is slight and only temporary, there is merely tingling or pricking, followed by numbness and a sense of warmth, with some loss of power over the movements of the part; in more severe cases, the anæsthesia and paralysis are complete, but the prognosis, if the cause can be removed, is usually favourable. Crutch paralysis is perhaps the most ommon form, sensation being less affected than movement, but both varyng very greatly in distribution. Whether the curious instances of paralysis f one or more of the nerves of the arm (sometimes of the whole brachial lexus) occurring during sleep, are to be accounted for in this way, or, as uchenne tried to prove, by cold draughts at night, is doubtful. The bsence of any evidence of neuritis renders the latter explanation very difficult o understand.

Stretching.—The effect of violent strain upon a healthy nerve is closely milar, the pathological lesion probably being of the same character—interuption of the medullary sheaths, with extensive disturbance of the axisylinders (rupture only in very severe cases), minute hæmorrhages, and, ubsequently, congestion. The worst instances occur in connection with islocations, the injury being caused sometimes by the pressure of the dislaced bone, sometimes by the tension to which the nerves are subjected at ne time of the accident or in subsequent attempts at reduction.

Treatment.—(*a*) When a nerve is divided in an open wound, the two nds should be found, brought together as accurately as possible, and sutured ith chromic gut or fine kangaroo tendon. There is no objection to passing he suture through the nerve itself; indeed, in the case of small ones, it is he only way in which it can be effected; but the needle used should be attened from side to side, so as to inflict the minimum of injury. In the ase of large ones the sheath should be sutured as well. The rest of the ound is treated according to the condition it presents: the limb placed pon a splint to prevent tension upon the sutures, and every endeavour made o procure union by the first intention.

As already mentioned, perfect recovery may take place within a fortnight, o that no difference is perceptible to the patient or to others. This, howver, is exceptional. In the majority, trophic lesions begin to show them elves, and then, slowly, after some months, disappear again, sensation eturning before movement, and voluntary power before electric excitability. o case should be considered a failure until at least a year has elapsed; ometimes no improvement can be detected for months, then it sets in and rogresses rapidly; sometimes it is steady and gradual from day to day. owlby explains the differences, in part at least, by the independent reeneration of the distal segment, which is no doubt hastened very coniderably as soon as connecting axis-cylinders develop in the intervening plice.

The ultimate prognosis is fairly good, but complete failure occurs in a ertain number of cases, partial failure in many more, delicacy of touch and ccuracy of movement being impaired; and in all, or nearly all, the sense f localisation requires re-educating. The presence of suppuration distinctly iminishes the chance; in one or two instances, indications of commencing ecovery have suddenly disappeared again, probably owing to the onset of nflammation checking repair.

(*b*) When the injury is a subcutaneous one from the commencement, or he wound (if there was one) has healed, every endeavour must be made to ssist the natural process of repair. Rest, pressure, bandages, splints, cold. osition and elevation may all, or some of them, be required according to he nature of the injury. Everything else must wait until time has been iven for the parts to be restored to their natural condition.

The only exception is in those cases in which the compression is progressive, due to some internal cause ; for these, naturally, something further is required ; callus, for example, if it does not soon become absorbed, must be cut away, and the nerve dissected out ; a cicatrix in the soft tissues must be treated according to circumstances ; an exostosis removed, or perhaps the nerve displaced a little to one side to avoid the offending body.

If the faradic excitability of the muscles persists, recovery takes place rapidly ; if it disappears and is succeeded by wasting and the reaction of degeneration (as always occurs after section) the prognosis should be more guarded, and means must be taken to maintain the nutrition of the part as soon as the fear of inflammation is past. Warmth, friction, massage, stimulating liniments, galvanism, everything in short that can improve circulation and nutrition is beneficial ; and, especially if there is any anæsthesia, great care must be taken to protect it from injury. The galvanic excitability increases in animals for some time after the faradic is lost ; but by the end of four months the muscles refuse to react to either. In man it is doubtful whether the increase takes place, but the galvanic excitability, at any rate, lasts very much longer than the faradic, and for this reason galvanism is preferred, as treatment, to faradism. The sittings should not be too long or too frequently repeated ; every other day for a quarter of an hour is usually enough, the time, of course, being chiefly determined by the extent of the paralysis and the number of muscles concerned. Massage should be applied afterwards, and a weak ascending current used at the end to diminish the sense of fatigue. The skin is thoroughly well soaked with salt and water first ; and care must be taken not to irritate an insensitive part by using a current that is too strong. An occasional interruption now and then, reversing the direction, is said to be very beneficial.

Increased sensitiveness of skin is the first sign of recovery. If this is noted, the treatment is continued in the same way ; in some cases improvement is very rapid ; the muscles soon regain their shape, although their strength and size and the accuracy of their movements may be defective for a long period ; in others it is much more slow. After section, voluntary power returns before electric excitability, but this is not invariable in subcutaneous injuries.

How long this should be continued, supposing there is no improvement, varies with each case. In a child, for example, repair, if it is going to take place, begins earlier than in an adult ; probably six months may be taken as the limit. If, at the end of this time, there is no sign of improvement, it does not follow that there never will be any ; but it is almost certain that it never will be very perfect, and that while secondary suture does not add any material risk, it offers the possibility of considerable benefit. If a neuroma has developed upon the central end, repair is hardly possible.

Secondary suture.—This may be performed at any time after failure of primary union. If an attempt was made to secure this at the time of the injury, it is advisable to wait for some months ; conductivity does not return equally soon in all cases. If no attempt was made, the sooner secondary suture is performed the better. According to Bowlby, so long as the case is of less than a year's duration, the amount of time does not influence materially either the rapidity with which union takes place or its perfection. After two years, however, perfect recovery is very doubtful, although a certain degree of improvement has been noted even at the end of twelve. As in primary suture, the period at which sensation and motion return is exceedingly ariable. The former has been known to appear again within twenty-four ours, or two or three days (and sometimes in these cases, probably owing o changes taking place in the wound, it fails later) ; while in other instances t has been months and even a year before there was decided improvement. The latter, as might be expected from the change the muscles have undergone, and the necessity for them almost to grow again, is longer still, months nd even years not being uncommon. No case therefore should be given up s a failure until at least two years have elapsed.

The method of performing the operation is very simple, although in arrying it out great difficulties may be encountered. Esmarch's bandage hould be applied, so that everything may be seen without confusion. An ncision is made over the seat of division, frequently traversing a scar, and he ends of the nerves sought. The upper one, especially if it is bulbous, usually presents but little difficulty : the lower, on the other hand, may be so hrunken, fibrous, and matted to the structures around that it can scarcely be ecognised.

The bulb on the upper one should be cut away and no more ; the less of the lower one that is sacrificed the better : it may appear hopelessly atrophied, but it is not in a more favourable condition farther away.

If after they are freed from adhesions, the ends can be brought together without much traction, they should be sutured with chromic gut as already mentioned. In many instances, however, there is a great gap between, and sometimes this is the case in primary operations when a considerable portion of the nerve has been lost or is too much bruised to live.

An additional inch or more may be obtained by stretching the ends, having first removed the bandage. If this fails there are various methods which have been recommended and some of which have been tried successfully.

1. Nerve-splicing is said to have succeeded (Desprès), the distal end of the divided median having been implanted between the separated fibres of the uninjured ulnar.

2. Flaps have been used. An incision partly through the trunk of the nerve is made some little distance from the end, and a flap of nerve-tissue reflected downwards from it, leaving it attached at its base, so as to bridge across the gap. This, too, is said to have been of use, sensation returning in four weeks and complete recovery in one year.

3. In a dog, the sciatic nerve was resected, the two ends sutured at some distance, and enclosed in one of Neuber's decalcified drainage-tubes. Union followed, but such a proceeding would be hardly likely to succeed in man.

4. The humerus has been resected in order to bring the ends together.

5. Grafts from animals have been used, portions of freshly excised nerves being embedded in the gap and fixed. In one case in which a rabbit's nerve was employed to replace part of the ulnar and median, sensation returned in four weeks and movement in nine, although the gap was more than two and a half inches in width (Tilleman's). In another case, in which the sciatic nerve of a dog was used, the result was doubtful.

6. Finally, Mayo Robson, in a girl fourteen years of age, removed two inches and a quarter of the median nerve for a neuroma, and two days later transplanted into the gap a portion of the posterior tibial from a recently amputated leg. Sensation began to return within thirty-six hours, and within four months was almost complete, although some of the muscles were still much wasted.

There is no doubt that any of these measures would be much more likel to succeed in a case of primary suture than where the distal end had bee already long separated from the proximal one. It is possible of course tha they show nothing more than that the nuclei of the sheath multiply mor rapidly, and arrange themselves more readily in rows when mechanical assistance is given them, and they are as it were directed into one particula line, instead of being allowed to coil up indiscriminately into a ball.

Complications

Injuries of nerves as a rule heal readily, whether the nerve-fibres unite or not. Occasionally they are followed by sequelæ, some of which are ver perplexing.

1. *Reflex Paralysis.*—By this is meant paralysis of one part of the bod consequent on injury to another with which the paralysed one has no direc connection. It may occur immediately after the accident, or some time ma elapse.

a. *Immediate.*—Most of the instances recorded are the result of gunshot wounds: a very severe injury is suddenly inflicted and a distant part of the body is paralysed almost at once. In all probability these cases are due to shock, although it is an open question how this produces such a result.

b. *Secondary.*—These are of a totally different character. A slight injury is inflicted upon one of the peripheral nerves; the muscles supplied by it gradually lose their power; anæsthesia, muscular cramp, and trophic lesions follow: other nerves become involved, first those distributed to the same limb, then the corresponding ones on the opposite side; and subsequently similar changes in nutrition make their appearance there. In short the symptoms are those of progressing chronic neuritis.

2. *Reflex Spasms.*—Trivial wounds of cutaneous nerves are occasionally followed by a peculiar series of symptoms of which tonic muscular spasm alternating with violent contraction is the most prominent feature.

In many cases it is distinctly traceable to neuritis; shortly after the injury the track of the nerve becomes exceedingly painful; the wound is exquisitely tender; and the least touch throws all the muscles around into a state of rigid spasm. In course of time as the wound heals this subsides; but the scar often remains painful and tender, and the least touch at one particular spot may bring all the symptoms back. In other cases, however, there is no evidence of any inflammatory affection at any time: the whole trouble appears to arise from a nerve-filament being entangled in the cicatricial tissue and irritated when the part is moved. This was apparently not infrequent in days gone by after the operation for venesection; some of the cutaneous filaments at the bend of the elbow were caught in the cicatrix, and the biceps and the other flexor muscles were thrown into a state of spasmodic cramp if the scar was touched or an attempt made to use the arm.

Reflex spasmodic contraction of an apparently similar description is common in children after slight injuries, especially those affecting joints. In them it is doubtful how far the disorder is due to the as yet imperfect development of voluntary control; and when there is no evidence or past history of neuritis spreading along the nerve, this should not be lost sight of in older patients, especially if there is a suggestion of hysteria. The treatment, if this factor can be eliminated, consists simply in excision of the cicatrix, or of the painful spot in it, as soon as the acute symptoms have subsided.

3. *Epilepsy.*—A few cases of epilepsy have been definitely traced to peripheral lesion as the exciting cause; the aura originates in the scar-sue and the least pressure is immediately followed by an attack. In any ch case, or where there is the least possibility of such a thing, the scar ould be thoroughly excised, or the nerves coming from it freely divided. e sooner this is done the better, for there is evidence to show that the nstant repetition of an irritation of this kind may at length lead to a ndition in which an exciting cause is no longer required.

4. *Tetanus.*—Whether this disease is ever produced by peripheral irrita-n is open to question. It certainly is one of the rarest of all rare compli-tions, if the number of accidents and operations in which nerves are jured is taken into consideration. On the other hand, its distinctly idemic occurrence, the period of incubation, and the general course of its mptoms strongly favour its microbic origin, even if no weight is attached the somewhat contradictory results of experiment. Probably the only lid reason for including it here is the occasional occurrence of tetanic con-actions after subcutaneous injuries (simple fracture for example) in which rves have been strained or stretched.

It must be remembered that tetanus, the disease, is a very different ing from spasmodic muscular contraction, even though this is tetanic in aracter.

NEURITIS

Inflammation of the peripheral nerves may be acute or chronic; in ther case the active changes are limited to the connective tissue; the edulla and the axis-cylinders are only involved secondarily.

Acute neuritis.—The whole nerve is swollen, softened, and intensely ngested. The sheath and the septa of cellular-tissue are thickened and filtrated with lymph; and in severe cases the section is stained with inute extravasations; but suppuration is rare. The myelin breaks up and sappears; the axis-cylinders become indistinct; the nuclei of the sheath e said to increase in number, and in the worst cases the whole appear-ce of a nerve is lost. Such extensive changes as this, however, are very rely met with.

Chronic neuritis.—In this there is an increase of all the connective-ssue elements of the part. The sheath is thickened and adherent to the ructures around; the nerve itself becomes hard and dense, shrinking after time to less than its normal diameter; and the fibres are atrophied and in eat measure disappear. The term chronic neuritis is, however, applied a very general way either to a true chronic inflammation with increased llular exudation and organisation, or to a simple process of degeneration, which the nerve-fibres atrophy in much the same manner as after section. many of the forms of so-called neuritis, there is no evidence, past or esent, of inflammation of any kind.

Causes.—Inflammation occasionally follows injury even when the skin unbroken: why, it is difficult to understand. Acute or chronic inflamma-n of the cellular tissue in or round a nerve can of course be caused by presence of foreign bodies or of micro-organisms; but the result is very ely proportionate to the cause either as regards severity or persistence of symptoms; and the worst cases not uncommonly follow such accidents as ains. There must be some other factor as well, very likely a personal one.

The influence of cold is variously estimated. The sciatic and facial nerves are the most often affected, the latter it is said being compressed by effusion in the bony canal, so that facial paralysis results; but according to Duchenne neuritis is much more common than is usually believed; certainly many cases of paralysis, especially of the musculo-spiral, commence during sleep, whether they are caused by cold or pressure.

Neuritis is not uncommon in gouty and rheumatic subjects as a result of exposure to cold and wet, especially after great fatigue. The fibrous sheath is filled with inflammatory exudation which compresses the nerve-filaments, and in all probability the nervi nervorum as well, judging from the intense local pain and tenderness.

In syphilis degeneration of peripheral nerves is not uncommon; and of course gummata occasionally develop in connection with them. In anæsthetic leprosy, a chronic form of inflammation is the essential lesion. The abuse of alcohol is stated to be the main element in the production of what is known as progressive multiple neuritis. Degeneration akin to inflammation, if not dependent upon it, occurs sometimes in locomotor ataxy, Pott's disease, chronic myelitis, &c. But even when full allowance is made for all of these, there is a very large residue for which no explanation is forthcoming. Some of the cases are distinctly inflammatory; others (those for instance associated with herpes zoster and sloughing bed-sores) only exhibit degenerative changes; there is no evidence of true neuritis; but the changes are so much more marked, and so much more rapid than those that follow simple section, that it does not appear advisable to separate them.

Symptoms.—1. *Constitutional.*—These depend upon the severity and extent of the inflammation; rigors, high fever, and delirium are present in the worst cases, but these are very rare. In chronic ones constitutional signs may be altogether wanting.

2. *Local.*—These vary with the character and connections of the nerve, whether it is motor or sensory. In acute inflammation the trunk is enlarged, excessively tender, and the skin over it is reddened and hyperæsthetic. There is the most intense pain, radiating over the whole area of distribution, sometimes of a burning character (causalgia) sometimes dull and aching, with numbing, pricking, and tingling sensations. Muscular twitching and fibrillar contraction may be present in the earlier stages, but tonic spasm is more common; and in a little while this gives way to loss of power, with rapid wasting and diminished faradic excitability. Paralysis, more or less complete, trophic changes of the most varied character, and anæsthesia are the final stages, the pain frequently continuing the whole time; but naturally the extent to which these occur differs in every case.

Traumatic neuritis is always local at first, but in many instances it spreads upwards along the nerve-trunks until it meets other branches involves these as well, and may finally implicate the whole of a limb. Then at length it subsides or becomes chronic, leaving the muscles wasted, the joints stiffened, the nerves thickened and tender on pressure, and the genera health, both of mind and body, impaired from prolonged suffering.

Other forms of neuritis are seldom very acute, although many of them especially the rheumatic, are often severe; pain, tenderness, swelling along the course of the nerves, wasting of the muscles and diminished faradic excitability are rarely absent; sometimes they are marked as in the traumatic variety; sometimes, on the other hand, as when the facial nerve i paralysed from cold, the effect is comparatively slight, consisting merely of temporary loss of power without any very perceptible alteration in the electric reaction.

A peculiar form of multiple neuritis is described as occurring in connection with alcohol and syphilis, although it is doubtful whether these are to be regarded as the sole cause. In some cases it is stated to have originated from cold. The hands and feet are first involved, the extensor muscles on the front of the leg suffering so often that, according to Buzzard, this of tself is diagnostic. The pain is intense; numbness with formication and a sense of fearful burning are nearly always present. The nerves are swollen and tender; the skin red and glazed; other trophic lesions follow and rapidly spread up the limb. Muscular power is lost almost from the beginning; reflex phenomena disappear; the reaction of degeneration sets n; wasting is extreme, the muscles remaining flaccid, without becoming ibroid; and the movements resemble those of locomotor ataxy. In some cases there is a considerable degree of fever as well, and the general health usually fails rapidly. The course of the disease is very variable; in a few cases it has continued to spread, commencing at the extremities and rapidly advancing until the spinal cord became involved; in some it has remained stationary for a long period, often at the level of the hands or feet, and then disappeared again, recovery taking place often under anti-syphilitic treatment; while in others again it has steadily progressed from bad to worse, until the patient died from exhaustion or was carried off by some intercurrent disorder. Some of these cases are difficult to distinguish from abes dorsalis; the gait is ataxic; there are girdle pains, and not unfre-uently lightning ones as well; but as a rule in spinal ataxy the electric eaction of the muscles continues normal.

Treatment.—Constitutional measures are most important. In the vast majority of instances, even if the inflammation is excited by cold or injury, its ersistence and severity are due to some other cause, whether gout, rheuma-sm, syphilis, malaria, chronic alcoholism or debility, and by itself local reatment is not likely to succeed.

In acute neuritis the first thing is to relieve the almost intolerable pain; armth, belladonna, fomentations, injections of morphia, Indian hemp, and ther anodynes are the most useful. Afterwards, when the first severity of he attack is past, narcotics, and opium in particular, should be employed as tle as possible. Counter-irritants, leeches, blisters, iodine, and even acu-uncture are of decided benefit; warm and Turkish baths frequently give great lief, particularly before going to bed; the constant current, interrupted casionally and preferably weak, but long continued, is often most successful; nd in the later stages, when the extreme tenderness has subsided in some easure, massage does more good than anything else, in all probability by using absorption of the inflammatory exudation, and preventing the forma-n of adhesions and dense cicatricial tissue.

Quinine and salicylic acid are sometimes very useful. Stretching the rve itself, paralysing the nervi nervorum and freeing the sheath all round, s proved of great benefit, even in such diseases as multiple neuritis and æsthetic leprosy, and in the worst cases is almost certain to give temporary ief.

NEURALGIA

By neuralgia in the general sense of the term is meant an acute paroxysmal pain in the course of a nerve. In many cases it is really a symptom of neuritis, or of disease of the brain or spinal cord, and the treatment must be guided by the cause. Sometimes, however, it does occur with great severity without there being any perceptible change in the nerve or the centre from which it springs.

Neuralgia of this type is nearly always due to some constitutional disorder, although it may be started by a local cause. Neuralgia of the testes, for example, arising from irritation of the kidney, or of the face from the presence of a carious tooth, is seldom severe except in those who are predisposed to it by a constitutional affection, whether it is mental or physical, hereditary or acquired. It is especially common among members of what may be called, for want of a better term, neurotic families. Anæmia, dyspepsia, over-lactation, mental worry or overwork, malaria, gout, debilitating influences of all kinds may induce it; but the worst form of all, that which is known as epileptiform neuralgia, or when it involves the fifth nerve, as tic, has so far eluded every attempt at finding a reason. It may occur in both sexes, in the young as well as the old, the robust as well as the weakly, and it may so completely destroy strength and health, both of mind and body, as to drive the patient to commit suicide.

This peculiar variety of neuralgia is usually met with in the face, affecting one of the branches of the fifth pair, or in severe cases all of them. The pain is paroxysmal, of the most intense description, coming on instantaneously from the slightest cause—a touch, a breath of cold air, an attempt at mastication, or even from no cause at all; it may last a few seconds or some minutes; and it may come on at frequent intervals, or not for days and even weeks. Whenever it occurs the sufferer describes it as the most intolerable agony, usually comparing it to something burning. There may be convulsive spasm with it (*tic convulsif*) or not; in many cases there is profuse lachrymation, in others the mucous membrane of the nose and mouth is hot and dry, occasionally the whole side of the face flushes, and in many instances the hair is affected too. Usually in its earlier stages it is traceable to some tooth as its starting-point, but in the true epileptiform variety it is not uncommon to find that the patient has had every tooth on that side of the head removed without experiencing even a temporary cessation.

Closely akin to this is a variety of neuralgia that is occasionally met with after amputations, different altogether from that which is due to the nerve-ends having become bulbous, or entangled in the scar. It does not begin until the wound is sound. The whole of the stump is the seat of a fearful burning pain, though to the touch it is intensely cold. The skin is red, glazed, and congested, the colour returning very slowly after pressure. The muscles of the joint above, and sometimes of the whole limb, are in a state of constant spasmodic twitching, and the pain radiates not only through the amputated part but over the whole of the limb. This (though, like tic, it may have commenced as a local affection from a local source of irritation) when once established is only too liable to become permanent, in the same way that local epilepsy sometimes does, either from constant repetition only, or from a peculiar unstable condition of the central nervous system; and I have known it return after four successive amputations, and even after the nerves had been stretched on the face of the stump as far as they could be without being torn out. No single one appeared to be involved, the disease, whether central or not, was general.

Treatment.—The ordinary form of neuralgia is only a symptom of an affection either of the nerve itself (neuritis) or of another part of the body, and the treatment essentially consists in finding the cause, whether local or constitutional. If nothing is discovered, all that can be done is to relieve the symptoms by large doses of quinine, salicylic acid, croton-chloral hydrate, or tincture of gelseminum internally, and anodynes—belladonna, veratria, aconite or menthol—locally. Naturally, as the constitutional condition that underlies the case may be of the most different description, the line of treatment required for one patient is often diametrically opposed to that advisable for another. Purgatives, colchicum, iodide of potash, and alkalies may suit one; while complete change of air, often to the seaside, rest, tonics, iron, quinine, arsenic, strychnia, or phosphorus may be required for another. Very great care is essential in advising stimulants or morphia.

Epileptiform neuralgia is rarely benefited except by operation, and even then in too many instances only temporarily. As a rule, by the time the neuralgia has assumed this type all the teeth on that side of the head have been extracted in the hope of obtaining relief. Sometimes this is successful, but in the worst form either the patient is entirely unable to state from what particular spot the neuralgia starts, or else, if there clearly is one offending tooth, no sooner is it removed than the pain transfers itself to another. Careful examination, however, should never be omitted; there is more than one case on record in which excision of part of the gum or of the alveolar border succeeded after all.

Quinine seems to have no control over it; anodynes soon lose their effect; morphia, if persisted in, only makes the condition of the patient worse. Galvanism is sometimes beneficial. If this fails, nerve-stretching may be tried, and as a final effort the whole nerve may be removed with its branches as far as possible, up to its exit from the cranium. The trunk most commonly affected is the superior maxillary, and there is a sufficient number of cases in which excision of Meckel's ganglion has succeeded to justify the operation. It is true, relief has not been permanent in all or nearly all, but in most it has lasted some months, in many one or two years, and that alone would be sufficient.

OPERATIONS ON NERVES

Nerve-stretching

The great sciatic may be stretched subcutaneously without a wound, and with almost as great success; in the case of other nerves an incision is required. If the cord is a large one, one or more fingers may be placed beneath it and steady traction exercised upon it, first in one direction, then in the other; as it yields a sensation as of crackling or snapping is transmitted to the finger, and the length and flexibility of the part exposed are distinctly increased. Small nerves should be lifted upon a rounded hook, sharp edges being avoided as much as possible.

The immediate effect is to loosen the sheath, separating it from all the structures around, and tear across the smaller vessels, so that its section is stained with minute ecchymoses. The myelin of the more superficial fibres is broken up into segments, many of the tubules are ruptured, and unless the force is very extreme, the excitability is increased for a time. In a little while the part becomes more vascular, some of the fibres degenerate and disappear, the nuclei of the sheath multiply, all the interstices are filled with lymph, and the fibrous tissue becomes swollen and softened. At this stage, after its temporary increase, the excitability of the nerve diminishes, anæsthesia and loss of power follow, corresponding to the fibres affected, and the faradic excitability of the muscles is greatly depressed. Gradually this gives way in turn to regeneration; new nerve-tubules are formed, the hyperæmia subsides, and at length all the functions of the part are restored.

It is especially noteworthy that the effect of nerve-stretching is not limited to the spot at which the traction is applied. It extends for long distances up and down the trunk, involves the branches that come off from it, and occasionally produces a considerable effect upon the spinal cord. It is probable that no degree of traction that can be safely exercised upon a nerve during life moves the cord to any appreciable extent; but whether this is the case or not, there is no doubt that hyperæmia of the columns of Goll may follow, and that sometimes, in animals at least, sclerosis of the posterior columns makes its appearance afterwards.

The effect varies with the force, and this of course is regulated by the size and the condition of the nerve. In some people the cords naturally stand a much higher strain than in others. The greater the length exposed the less the risk, as the force is more distributed. There is not so much fear of the nerve giving way as of its being pulled out from its spinal attachment, and great care therefore must be used when the part exposed is situated near the intervertebral foramina, and the traction is from the centre. In any case the pull must increase uniformly without the least jerk.

To stretch the sciatic nerve subcutaneously the patient is placed under an anæsthetic, and the hip flexed while the knee is kept in rigid extension, until a sufficient effect is produced. The hamstring muscles suffer to a certain extent at the same time, the ischial tuberosity being very tender for days afterwards. I have done this with temporary benefit on more than one occasion, but it does not free the sheath of the nerve from surrounding adhesions in anything like the same degree.

Neither operation is devoid of risk, especially in the case of the sciatic. Paralysis of other nerves coming up from the same region of the cord has been known to follow, and even the corresponding one on the opposite side of the body may suffer. Meningeal hæmorrhage, meningitis, and myelitis have all occurred and have proved fatal; and in other cases sloughing bedsores, cystitis, suppurative nephritis, and other trophic lesions have followed. Whether the frequency with which these occur after operations upon the sciatic is simply due to the fact that this nerve is more often affected than others, or to the exceptional amount of force that is sometimes used, as there is so little danger of tearing the trunk, is not known.

The good effect that follows the operation in so many different diseases has been accounted for in many ways. There is no doubt that old adhesions are broken across, and the cord freed from constricting bands. In other cases, when the neuralgic pain is local, not referred to the periphery of the nerve, the benefit may be due to the effect upon the nervi nervorum.

Something, perhaps, may be said for the increased vascularity that follows; the fibres are better supplied with blood and better nourished. But in all probability the chief good is due to the actual interruption of the fibres, both of the trunk and its branches, securing physiological rest for the centre until its normal nutrition is restored.

The effect (except where there is some local reason, such as chronic inflammation or the presence of adhesions) is usually temporary. When the nerves are regenerated, the old symptoms return again; either the original cause still remains at work, or the effect upon the centre has been repeated so frequently and for such a length of time that habit has become second nature. Sometimes, however, the interval is sufficiently long, the vicious circle is broken and the patient remains free.

Nerve-stretching has almost superseded nerve-section: it produces the same effect without interrupting the physical continuity of the cord; it acts upon the branches as well as the trunk; a longer section of the nerve is examined, and adhesions, if there are any, are broken across. The wound is a larger one it is true, but that is scarcely a serious objection.

Its chief use is in connection with all forms of neuralgia and chronic neuritis, even that which occurs in anæsthetic leprosy. In many of these cases it is extraordinarily successful. Epileptiform neuralgia, however, is usually only relieved; it is almost certain to return. In addition it has been used with varying success in tabes, both to relieve the pain and for the ataxic symptoms, and in facial tic. In spastic spinal paralysis, tetanus, paralysis agitans, and spasmodic wry-neck, its value is very doubtful; sometimes it is said to have procured temporary relief, but it is not probable that the whole number, or even a large proportion of the cases in which it has failed, has been published.

NEURECTOMY AND NERVE-EVULSION

The former of these signifies merely the removal of a portion of a nerve-trunk; the latter, &c., complete separation from the highest point that can be reached, as a rule the orifice of a bony canal.

Neurectomy is practised upon the spinal accessory for uncontrollable spasmodic wry-neck, and occasionally upon the nerves of the head and face for neuralgia. Nerve-evulsion is rarely tried except in the case of the second and third branches of the fifth for epileptiform neuralgia.

Meckel's ganglion may be excised, either from the side or in front. In the former operation the zygoma with the attachment of the masseter is separated and reflected; in the latter the anterior wall of the antrum is trephined. If the light is good (an electric light or at least a reflector attached to the forehead of the operator is essential) the anterior operation is quite feasible, and though permanent cure is rare, may be relied upon to give relief for at least one or two years. A crucial incision is made down to the bone over the infra-orbital foramen; a half-inch circle is removed with a trephine from immediately below it, and the nerve traced back, cutting away the floor of the infra-orbital canal and groove until the posterior wall is reached. A second trephine opening is made in this, taking care not to wound the soft tissues beyond; and, as a rule, Meckel's ganglion is exposed at once, and can be removed with its posterior dental branches and the whole length of the infra-orbital, thus securing complete anæsthesia of that side of the palate.

The inferior dental nerve may be exposed through the vertical ramus of the jaw, a circle of bone being excised with a trephine; but in most cases it can be reached as satisfactorily through the mouth, and a disfiguring scar avoided. A gag should be placed between the teeth on the opposite side, and the mouth opened as widely as possible; the incision runs along the projecting fold of mucous membrane, passing from one jaw to the other behind the last molar teeth, and the finger is pushed between the internal pterygoid muscle and the ramus until the sharp spine of bone that marks the orifice of the dental canal is reached. The nerve may then be hooked forwards with an aneurysm needle, and separated from its connections for some little distance with the finger. Care must be taken not to mistake the long internal lateral ligament of the lower jaw for it.

NEUROMATA

True neuromata—that is to say, tumours composed of nerve-tissue—are very rare. A few cases are recorded in which nerve-fibres (usually small and without much myelin) have been found, and, in one or two, nerve-ganglion cells as well; but the total number is very small, and there is no means by which they can be distinguished from false ones during life. The nerve-fibres are not arranged in any definite order, and do not communicate with those of the trunk upon which they grow.

False neuromata are fibromata, sarcomata, or cysts developed in connection with the fibrous tissue of the nerve. They may attain any size and grow either on the side of the nerve or in among the fibres, displacing them. Sometimes they are multiple, as many as two thousand having been counted in one individual, and these are not unfrequently associated with molluscum fibrosum. Occasionally their section presents a plexiform appearance. The symptoms naturally vary with the kind of nerve from which they grow, and the extent to which they interfere with its functions. Shooting pain, especially when the growth is handled in a particular way, neuralgia, paralysis, spasm, trophic lesions, and even paraplegia (when the tumour is situated in the spinal canal) have been described in connection with them.

Neuromata must not be confused with the bulbous enlargements which make their appearance upon the ends of nerves after section, although the microscopic appearance is closely similar.

Excision is the only treatment. If the growth proceeds from one side of the trunk there is no difficulty; if, however, it is interstitial this may be impossible. Under these conditions the only course open is to excise a portion of the nerve, and bring the two ends together if possible by means of sutures.

CHAPTER V

INJURIES AND DISEASES OF MUSCLES, TENDONS, ETC.

Sprains and Contusions

Contusions of muscles are rarely serious, although they may cause considerable effusion of blood, with pain and loss of power. In a few instances, however (especially in the case of the quadriceps femoris) permanent atrophy has followed. I have known the same thing occur after a violent sprain, and that too without the fibres being torn to any extent.

Tendons themselves seldom suffer; the soft delicate sheath that surrounds them receives the brunt of the violence. Repeated strains, however, are not unfrequently followed by chronic inflammation, which may end in ossification. The best known example is what is called rider's-bone, developing in the tendon of the adductor longus in those who are accustomed to rough riding, but I have met with similar ones in the tendons of the psoas, quadriceps, and biceps. In chronic rheumatic myositis the tendinous expansions attached to the bones often become ossified, so that the intermuscular ridges stand out, covered with irregular osteophytes. This condition, however, is rarely diagnosed during life.

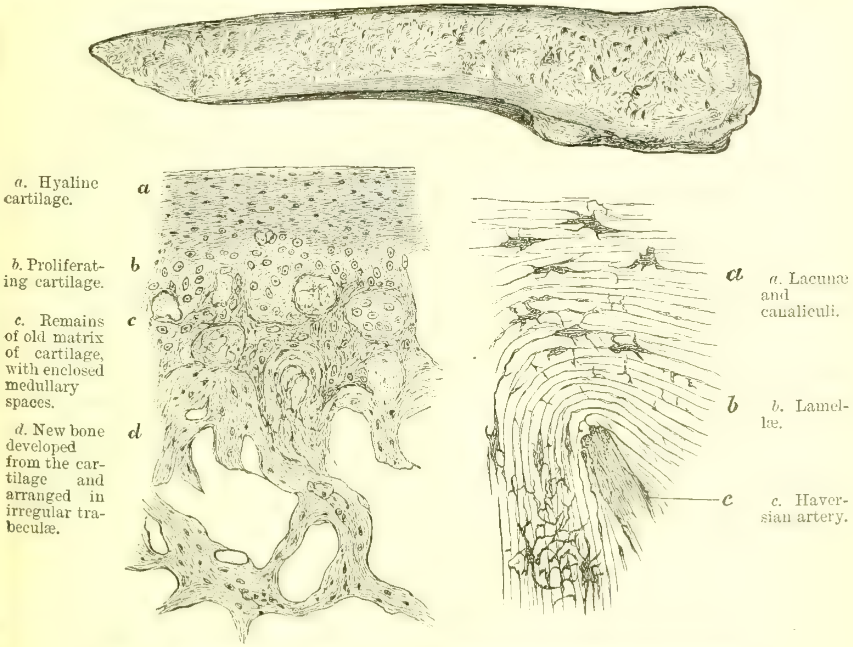

a. Hyaline cartilage.
a
b. Proliferating cartilage.
b
c. Remains of old matrix of cartilage, with enclosed medullary spaces.
c
d. New bone developed from the cartilage and arranged in irregular trabeculæ.
d
a
a. Lacunæ and canaliculi.
b
b. Lamellæ.
c
c. Haversian artery.

Fig. 67.—Rider's bone seen in section, with its microscopical appearance.

Rupture

Muscles are torn by external violence; by sudden spasm as in tetanus; or by splinters of bone being driven into them in fracture; and the injury may be either simple, with the skin unbroken, or compound. In cases of external violence, the rupture may of course involve any part; the sheath only may be torn, or the whole thickness of the muscle. When it is due to sudden contraction the fibres are usually wrenched out from the tendons, the line of junction being the weakest part. If, for example, the last phalanx of one of the fingers or the thumb is pulled off, it brings with it the whole length of the flexor tendons (fig. 68).

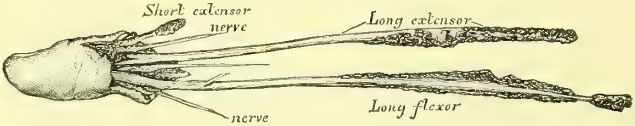


Fig. 68.—Thumb, with tendons, &c., torn out by machinery.

The signs of such an accident are very conspicuous. There is a sudden sharp pain followed by a dull sense of aching and of helplessness, and a feeling as if fluid were trickling down the skin. The ends retract immediately as far as they can: an immense amount of blood is poured out; and the separation grows more distinct with every attempt to use the part. By degrees the blood is absorbed; the swelling becomes less prominent, the lymph that is thrown out becomes organised, and, if the interval is not too wide, a splice of cicatricial tissue is developed. Later it appears that this is in some measure replaced by muscular elements again. If only the investing fascia gives way the muscle-substance is squeezed out through the rent, and forms a mushroom-shaped swelling known as a hernia.

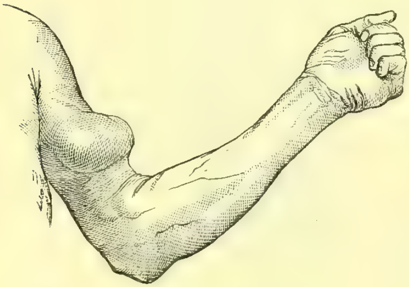


Fig. 69.—Ruptured tendon of biceps.

The adductor longus often suffers in this way in the almost involuntary grip upon the saddle when a horse swerves; and full power is seldom regained. The biceps in the arm; the quadriceps in the leg; and the rectus abdominis, among the flat muscles, are ruptured almost as frequently. Others are seldom injured; but the lower part of the pectoralis major may be torn (when, for instance, a person tries to save himself from falling by clutching at something); the sterno-mastoid may give way from vomiting, or (probably from excessive traction) during birth; and the biceps femoris, the semi-membranosus, and many others occasionally suffer. Whether the plantaris ever does is, I think, open to question. There is a well-known form of accident, the symptoms of which are always strikingly alike, known as lawn-tennis leg, or as the 'coup de fouet.' It is rare among women and among hospital patients, but exceedingly common in men past middle life and of a somewhat gouty tendency. There is a sudden violent pain in the calf of the leg, like a whip-stroke, and the patient stops involuntarily, whatever he may be doing, with his leg perfectly helpless. In a few minutes a little extravasation makes its appearance behind the inner malleolus; a certain amount of puffiness and œdema may occur as well; and then the pain subsides. The toe is placed upon the ground, but not the heel; all the resolution the patient is capable of cannot bring it down; the weight cannot be borne upon the leg; and walking is out of the question. In some cases a slight degree of eversion of the foot has been noticed. This peculiar accident is always attributed to rupture of the plantaris tendon, but I am not aware of any instance in which this lesion has been demonstrated. On the other hand, I know of at least one case in which the same accident occurred twice in the same leg at a different spot within the month. From the symptoms, the class of person in whom it occurs, and the rapidity with which recovery takes place, if proper measures are taken (not without), I am inclined to think that it is rather a rupture of some one of the deep-seated veins which are so often varicose than of that exceedingly long tendon.

Treatment.—The limb must be placed in the position that secures the maximum degree of relaxation, and the extravasation checked as far as possible by cold and pressure. Firm bandaging assists in keeping the muscle from contracting and helps to press the broken surfaces somewhat nearer. Afterwards the part must be kept absolutely at rest until organisation is complete. If union takes place the nutrition will soon recover under the influence of massage and galvanism. When the tendo Achillis is ruptured a high-heeled shoe must be worn for two or three months afterwards.

If the ends cannot be brought into fair apposition, union of course is impossible. The gap grows wider and more distinct as the blood that fills it is absorbed; the ends of the muscle atrophy; and its use is entirely lost. In many cases some appliance is needed afterwards—an abdominal support, for example, to prevent ventral hernia, or a thigh-belt if the adductor is ruptured.

In open wounds an attempt may be made to draw the surfaces together by deeply-buried catgut sutures passed through the whole thickness of the muscle, or through its investing layer only, but it rarely succeeds. With tendons, on the other hand, primary suture is very successful and should always be practised. Chromic gut is the best material, the sutures being passed through the thickness of the tendon, and the wound, if necessary, enlarged for the purpose. At the wrist, where deep transverse cuts are of common occurrence, this is specially important; but the tendo Achillis and many others have been joined again in this way. Even secondary suture, freeing the ends from the cicatricial tissue around, freshening them, and fastening them together, is very often successful; but the greatest care must be taken to secure union by the first intention, and the limb must be held rigidly fixed for some little time upon a splint, to avoid the smallest accidental movement.

Where the interval is too great the tendon may be split and the two ends spliced, as described in speaking of nerve-suture. In one or two instances resection of the shaft of the bone has been performed to reduce the size of the gap; and transplantation of a muscle from a dog into the biceps is said to have succeeded.

Rupture of the plantaris tendon requires an entirely different method. The limb must be raised for a few minutes in order that the œdema may subside; and then carefully strapped and bandaged from the foot upwards.

As soon as this is accomplished the patient is to walk with his heel well down upon the ground; the sooner it is done, the more speedy is recovery; prolonged rest always leaves a most serious degree of stiffness, probably from the organisation of the extravasated blood tying together all the planes of cellular tissue between the muscles. The bandage should be renewed as soon as it becomes loose, and should be kept on for eight or ten days. Any stiffness that is left disappears rapidly under massage and hot douching. Reunion of the tendon, if it is really ruptured, does not appear to be material.

DISLOCATIONS

The peronæi tendons are occasionally displaced from behind the external malleolus in severe sprains of the ankle, in spite of the tough fibrous sheath that binds them down. Reduction is easy, but often it is almost impossible to retain them in position. The foot should be carefully bandaged, with firm pressure behind the bony projection, and passive motion commenced at the end of the first week at the latest. It often happens, however, in spite of every care, that repair is not perfected, and that some trivial slip, even months later, tears the old wound open again.

The extensor tendons on the back of the wrist suffer in the same way, but rarely give rise to more than temporary inconvenience. There is a moment's pain; the tendon slips back, and, beyond a certain feeling of soreness and weakness, the use of the hand does not suffer.

The long tendon of the biceps may be displaced from its groove, although no doubt many of the cases in which this accident has been diagnosed are really the result of rheumatoid arthritis. There is a sudden twist with a sensation of sickening pain, and the use of the arm is restricted in certain directions; it cannot be raised above the level of the shoulder, and the head of the bone is too prominent in front; then, suddenly, after a little manipulation, a snap is felt, and full power is regained almost immediately. In one case under my care this occurred on several occasions, the patient being able to throw the head of the bone out of gear, as it were, almost at will; and although the diagnosis was not verified, it is difficult to understand what other kind of lesion could have given rise to so peculiar and constant a train of symptoms.

Similar accidents have been recorded in connection with other tendons. Thus the tibialis posticus may be displaced from behind the internal malleolus in the same way as the peronæi on the outer side of the foot; and the sartorius may be forcibly wrenched from its surroundings at the knee-joint (especially when the knee is flexed); but these are all rare. Displacement of the tendon of the quadriceps in cases of genu valgum is regarded rather as a dislocation of the patella.

The slender muscular slips that lie packed side by side in the neck and in the loins are sometimes displaced; but it is doubtful whether this should be called a dislocation. It usually occurs in some sudden awkward action, when, for example, the head is twisted round to look upwards. There is a sensation of something giving way, or of a snap, with acute pain; and the head is either fixed, or is very slowly and painfully brought into a straight position again. In some instances this is caused by the momentary locking of the articular processes, or strain of the capsular ligaments; but occasionally a distinct, elongated, and very tender swelling has been noted, and complete relief has followed rapid manipulation, the muscle being pressed back into the position while the patient endeavours by some sudden action to make it contract. Many of these cases, however, are probably due to tearing of the membranous fascia enclosing the muscle and partial hernia; or to rupture and extravasation in its substance. Either of these hypotheses would explain the facts equally well.

ATROPHY

Muscular atrophy may be due to the supply of blood being insufficient; to affections of the nerves or nerve-centres; or to both together.

Deficient supply of blood, such as arises from disuse, the pressure of an elastic stocking, or the ligature of the main artery of a limb, causes simple wasting, with or without fatty degeneration. The electric reaction is not affected; the size and strength of the muscles diminish; they lose tone and feel soft and flabby to the touch, but it requires nothing more than increased vigour of circulation to restore them. As soon as the cause is removed, they begin to improve at once with massage and galvanism.

Atrophy due to affections of the nervous system is more serious. If the nerves are divided, faradic excitability diminishes from the first, and may disappear altogether in the course of a few days. The same thing occurs with the slowly interrupted current; but, for a little while (at any rate in animals), the irritability appears to be increased, and a peculiarly slow and continuous contraction is caused by stimulation that is not strong enough to make any impression upon a healthy structure. This may last for a week or two, but rarely for much longer; and at the end of three or four months, if the separation is complete, the muscles are insensitive to stimuli of all kinds. The atrophy that occurs in connection with neuritis is almost as rapid; but the worst examples of all are seen in infantile paralysis, and progressive muscular atrophy, when the centres in the anterior cornua of the spinal cord are destroyed. In these diseases the corresponding muscular fibres may waste so completely that no trace of them can be found.

Muscular atrophy following lesions of the motor area of the brain is not accompanied by the reaction of degeneration; the fibres simply waste away from want of use. Rigidity, tremors, and contraction, however, follow if secondary descending sclerosis sets in and involves the motor tracts in the spinal cord.

FUNCTIONAL DISORDERS

Loss of power, with or without spasmodic contraction, is sometimes met with in muscles that are constantly overworked; and as no definite lesion is known to exist, it is usually described as functional impotence and functional spasm. It may affect a single muscle by itself (the peronæus longus for example), so that it either remains powerless or in a state of rigid contraction, instead of shortening and relaxing in harmony with the rest; or more frequently it involves a group associated together for some particular action, and only when that action is being carried out; for all other purposes they are as strong as they were before.

The most common example is known as *writer's cramp*, the muscles of the hand being affected only when an attempt is made to grasp and direct a pen; but it is frequently met with in other occupations (so that it is sometimes known as a professional neurosis) especially those in which finely adjusted movements are kept up without intermission for a great length of time. At first there is little more than a sense of fatigue; the pen is grasped more tightly, or is held in some unusual way; then involuntary contractions set in; at the beginning they are only of momentary duration; soon they become more persistent and exaggerated; the more attention that is paid to them, and the greater the effort, the worse they grow; the muscles of the forearm become involved as well as those of the hand; even those of the head and neck may suffer; then they spread to the opposite side of the body; and finally, the least attempt at placing the hand in position is sufficient to throw it into a state of the most violent and painful agitation.

The electric excitability of the muscles is usually slightly depressed; the nerves, especially the median, are tender on pressure; neuralgic pains are very frequent, at first only when the one particular action is attempted, but later more constantly; and partly from this, partly from the mental distress, the general health fails and the nutrition of the muscles becomes still more impaired; but there is no evidence of neuritis or of any gross pathological lesion. It may occur even in those who are strong and healthy; but it is distinctly more frequent in members of neurotic families; and in a few cases it can be traced, in part at least, to slight hemiplegic attacks occurring at an earlier period of life; recovery is perfect for all ordinary actions, only unusually delicate combinations such as these are carried out at a disadvantage, and fail in perfection sooner than they otherwise would. The style of writing is probably of some importance. Those who rely upon their fingers only, who do not use the wrist or forearm, appear especially subject to it. Shorthand writers, whose style is necessarily very free, are seldom affected.

It is probable, as Vivian Poore suggests, that these disorders (or at least writer's cramp, which may be taken as the type of the rest) are due to neuromuscular fatigue, the tenderness along the course of the nerves, the tremors, and the diminished excitability all being susceptible of the same explanation. Certainly the most successful remedies are those which tend to improve muscular nutrition. Massage, combined with passive motion and suitably arranged exercises, has met with the most conspicuous success, cases of many years' duration having begun to improve almost at once, and having been at length completely cured, so that full power of writing was regained. At the same time, tonics, galvanism, and local injection of strychnia are of very great assistance. Rest alone effects but slight alleviation, and that only of a temporary character.

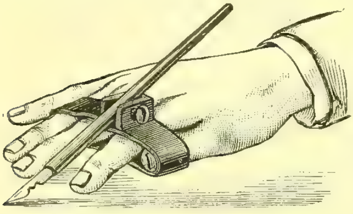


Fig. 70.—Nussbaum's instrument for writer's cramp.

In early cases the appliance invented by Nussbaum may be used with benefit. It is framed to exercise the extensors and abductors of the fingers, so that they may be better able to resist and overcome the spastic contraction of the flexors and adductors (fig. 70).

Contracture or Permanent Shortening

This is distinguished from ordinary muscular rigidity (such as occurs in the early stages of inflammation of a joint and in hysteria), by its not relaxing under an anæsthetic. The change is in the sheath and the connective tissue of the muscle; the fibres atrophy, the cross section is very much diminished in size, and in some of the more extreme cases scarcely any trace of true muscle substance is left.

It is produced in various ways. A mild form of it may be caused by prolonged rest in one position, as in the case of the gastrocnemius when the patient is confined to bed: the worst cases are usually the result of chronic inflammation of the muscle itself, descending neuritis, or persistent irritation along some portion of the motor tract. Hence its frequency in descending sclerosis following lesions of the cortex.

Slight cases, provided the cause is not a persistent one, can be cured by massage and passive motion; tenotomy, however, is often necessary in old joint disease, before the parts can be restored to their natural position. Section should always be subcutaneous, and performed at the spot at which the muscle (or preferably its tendon) is most superficial and farthest away from important structures.

Myositis

Subacute inflammation of muscles usually occurs in connection with gout, rheumatism, and exposure to cold and wet, or it follows prolonged overwork, or a sudden strain rupturing some of the fibres. The pain is often severe, especially at night, and when an attempt is made to move the part; and this, combined with stiffness, is the most conspicuous feature. Fever, swelling, and local pyrexia are seldom present. Inflammation due to other causes is more rare, although it sometimes extends into the muscles from he surrounding structures, and occasionally arises from direct infection hrough a wound or through the blood.

In chronic inflammation the exudation becomes organised and contracts while the muscular substance itself wastes and degenerates. In many cases his ends in a condition of rigid contracture, requiring prolonged massage nd even tenotomy before use of the part is regained; and ossification is not ncommon, spreading from the insertions of the muscles into the tendons and long the fibrous septa, until the bones are covered with irregular osteophytes.

Suppurative myositis may either occur as a local affection (an abscess orming in the substance of the muscle, from injury or the impaction of foreign body), or as part of a general infective disorder. Diffuse suppurave myositis, for example, sometimes breaks out under the same condions as diffuse inflammation of the cellular tissue, or diffuse suppurative eriostitis, although it is much more rare; the pyogenic organisms gain ccess to the part through a wound, or when the skin is unbroken through ne of the mucous surfaces, and owing to their being accidentally favoured some way (by extreme fatigue for instance) give rise to wide-spreading ppuration.

In addition to this, a few cases are recorded of an *acute progressive yositis*, involving all the voluntary muscles of the body, and generally oving fatal from asphyxia or pneumonia. It appears to resemble trichinosis in many of its features, and in all probability is parasitic, although as yet no actual evidence is at hand. Inflammatory swelling of the muscles with the most intense pain, so that the patient can barely move; an urticarial or papular eruption upon the skin, followed by œdema, and rapidly increasing weakness have been noted in all; while in some there was cramp, or a tonic contraction of the muscles, with insomnia, and profuse sweating. The diaphragm, heart, and bladder appear to escape.

In all the cases examined evidence of acute inflammation has been found, sometimes parenchymatous, the fibres being pale, rigid, friable, and infiltrated with serum; sometimes, on the other hand, interstitial with hæmorrhages scattered everywhere among the fibres.

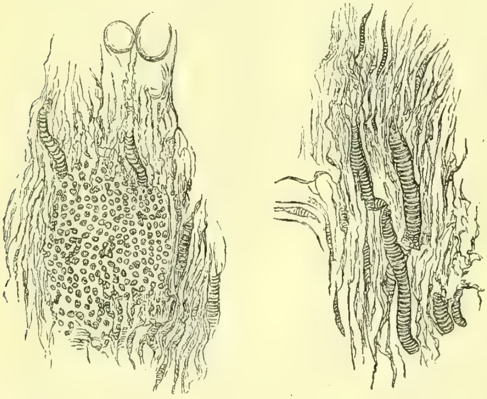


Fig. 71.—Showing the early or cellular stage.

Fig. 72.—The late or fibrous stage.

From a case of sternomastoid induration in an infant.

Gummata are not uncommon, especially in the tongue and the sterno-mastoid. In the latter muscle a peculiar firm and hard nodule, which is certainly not always due to syphilis (figs. 71 and 72), is sometimes noted shortly after birth. In most instances it appears to be traumatic.

Leprosy, tuberculosis, and other similar diseases give rise at times to specific deposits among muscular fibres, as in other tissues.

A very peculiar form of inflammation is occasionally met with (*myositis ossificans*), in which large plates of bone are developed, chiefly in the dorsal region, but also all over the body, in the substance of the muscles, so that the bones become united together by osseous sheets of the most fanciful shapes. Nothing is known as to its pathology.

TENOSYNOVITIS

The synovial sheaths of tendons resemble the deeper bursæ and the lining membranes of joints in structure and pathology. Inflammation may be caused by any continued irritant, organised or unorganised. The simplest form is that due to mechanical injury, such as tension or overwork; others, more severe, are the result of specific ailments, gout and rheumatism for example, or of infection, as in tubercle and syphilis; suppuration never occurs without the presence of pyogenic micro-organisms, whether they come through a wound, through the blood, as in pyæmia, or directly from surrounding structures.

1. *Acute.*—Simple acute teno-synovitis is caused by strains or prolonged overwork. The course of the tendon is marked out by an ill-defined swelling, the skin over it is tender and sensitive, the temperature is slightly raised, the action of the muscle is painful, and whenever the part is used or moved in any way there is a peculiar soft crepitus, as of two pieces of silk gently rubbed together. The endothelial lining is detached, the surface

overed with lymph, and the least movement causes friction. In more evere cases the exudation involves the loose cellular tissue around as well as he tendon sheath itself; often it is mixed with blood, and the pain, heat, nd tension are more severe. The whole of the dorsum of the hand and orearm, for example, may be swollen and œdematous, and the bruising xtend far above the elbow, after a fall upon the back of the hand, doubling he wrist upon itself.

The subsequent changes are the same as those that occur in other parts nder similar conditions. The whole of the exudation may be absorbed ithout leaving after-trouble of any kind. Part of it may undergo organisa- ion (especially if there is some constitutional ailment present, keeping up a ersistent though slight degree of irritation), so that the attack becomes hronic; or suppuration may follow.

2. *Chronic tenosynovitis.*—Chronic inflammation may begin as such, or ollow an acute attack, kept up either by a constitutional cause, such as gout r rheumatism, or by the presence of adhesions. This is a frequent result f over-caution, and the fear of passive motion in the treatment of sprains nd other injuries. The tendon-sheath, after some slight accident, is filled ith lymph, which becomes organised and forms bands extending between ontiguous structures, tying them together. At first these are thin and elicate, and break down at once; but if the parts are kept at rest too long, ey grow firm and rigid, and then unless they are torn right in two, or at ast are stretched to such an extent that no more tension falls upon them, ey become the cause of fresh attacks. Every contraction of the muscle rains them, and gives rise to pain; fresh effusion follows, and this in its rn becomes organised, and makes them stronger still. The frequent petition only makes matters worse, while one sudden, and sufficiently gorous, well-directed wrench would remove the cause, once for all.

The pain in chronic tenosynovitis is very variable; usually it is rather of dull aching character, with a sensation of soreness; it is never intense and robbing as in the acute form. The temperature is only slightly raised, ere is little or no redness of skin, but the swelling is generally conspicuous, volving the loose tissue around as well as the sheath itself, and attended th great impairment of power. In many cases the effusion is simply ous, but it may be thickened, almost gelatinous, or mixed with myriads of lon-seed bodies, all practically the same size and shape, consisting of centric laminæ of fibrin, developed from the lymph poured out on the lls and septa. The inner surface may retain its normal smooth character, not unfrequently, especially in rheumatism and in the neighbourhood of nts affected with osteo-arthritis, it is rough, irregular, and covered over with sses of dendritic outgrowths which can be felt rustling and crepitating h every movement.

Tubercular inflammation is met with most frequently in the large sheaths ich spread along the flexor tendons under the annular ligament of the st. The walls and mesotena are enormously thickened and converted into nulation-tissue, similar to that met with in tubercular synovitis of joints. fluid in the interior may be gelatinous like that found in ganglions, or id from the exudation mixed with it; but it is rarely much increased in ntity. The lining membrane is softened and rough, the movement of tendons impaired, and the use of the part greatly limited. The most ninent symptom is a chronic painless swelling, occurring, as in compound palmar ganglion, above and below the annular ligament of the wrist, soft and elastic to the touch, but not fluctuating, and not admitting of its contents being driven from one compartment to another.

3. *Suppuration.*—This may be caused by direct infection, as after amputation of the toes when long open channels are left, placed vertically in the most convenient position for receiving all the discharges of the wound; or by pyæmia, or by extension from inflammation near. The most common situation is on the fingers (*thecal abscess or whitlow*), owing to the frequency with which poisoned wounds occur, and the peculiar distribution of the lymphatics. Instead of the loose, horizontal arrangement which prevails in the subcutaneous tissue of other parts, the general direction of all the fibres and lymphatic spaces in the fingers is from the skin towards the periosteum or the tendon-sheath, and any poison that is inoculated on the surface is carried down to the deeper structures, causing inflammation, which is all the more severe because of the dense unyielding character of the tissues. This is the explanation of the frequency with which periostitis of the last phalanx and acute suppuration in the tendon-sheath occur. The poison spreads down to the bone, which speedily becomes inflamed and perishes (the proximal end and the joint often remaining intact), the tendon sloughs, and the finger is left distorted, stiffened, and useless. Fortunately the sheath, in the case of the first three fingers, does not communicate with the general one, but extends no farther than the heads of the metacarpal bones. In the thumb and little finger, however, it does, and if acute suppuration occurs in connection with them the sloughing is very likely to involve the whole of the flexor tendons, the hand may be riddled with abscesses and the pus may spread into the carpal joints, or even in the deep planes of the cellular tissue up the forearm, and endanger life itself.

Owing to the extreme tension, acute suppuration in the tendon-sheaths of the fingers is attended with very severe symptoms. There may be a rigor; the temperature is raised many degreees, the finger throbs and burns, especially if it is allowed to hang down, the skin is hot, glazed, and exquisitely tender, and movement is impossible. For the same reason, the dense character of the tissue on the palmar surface, the swelling is usually slight. Often it is more marked upon the back of the hand, the poison passing from the sheath into the cellular tissue around; and in severe instances it is accompanied by lymphangitis and deep-seated brawny, infiltration of the tissue of the forearm.

On the other hand, in pyæmia, suppuration may make its appearance in some loose and large sheath as insidiously as in the case of joints, without tension, redness, or pain. The consequences, however—the extension into the cellular tissue round, and the implication of neighbouring synovial cavities—are no less certain when once the resisting power of the tissues is overcome by the continued action of pyogenic germs.

Treatment.—The general principles are the same as in the case of joints. When the symptoms are acute the limb should be placed upon a splint, kept at perfect rest, raised to check hyperæmia and carefully and evenly bandaged, the line of the sheath being covered with many layers of cotton wool. If this is not practicable, cold or lead lotion may be used. Passive motion should be commenced as soon as there is a sensible reduction in the quantity of the effusion; moving the tendon once or twice each day quietly and steadily will prevent the formation of adhesions without making the inflammation more severe.

As the attack subsides, counter-irritation may be used with benefit. Masage, owing to the peculiar situation of the tendon-sheaths, is of especial ervice. Hot douching, steaming, fomentations, friction, and passive moion are of very great use as soon as the temperature of the part is normal. Sometimes, particularly when there is one very tender spot, an adhesion can be ruptured under an anæsthetic and the tendon released. In most of the cases, however, in which there is persistent stiffness, it depends not so much upon the presence of bands and adhesions as upon the defective state of nutrition. The tendons and their sheaths have been injured, and kept at rest for weeks together; the circulation through them has been reduced as ow as possible; the plasma upon which their nutrition depends has been allowed to remain stagnant in the interstices, and active work is out of the question. Under these conditions, when once the acute inflammation has ubsided, and the temperature of the part fallen to normal (very often it is ower than this, and the skin is blue and congested), everything is beneficial hat encourages the flow of blood through it; the more it is used, the sooner t recovers.

If there is a suspicion of suppuration, an exploratory puncture should be made without delay, and if pus is found the incision should be very free, so hat there can be no possibility of tension or accumulation of decomposing fluid. Otherwise the tendon is sure to slough, and the neighbouring bones and joints very likely become involved as well. A median incision may be made down the centre of each finger on the palmar surface, as far as the irst deep transverse groove that forms on the palm when the fingers are flexed; the radial and ulnar compartments of the palmar fascia may be freely opened, and even the anterior annular ligament divided in preference o allowing the pus to spread under high tension up the deep fascia of the imb. Fortunately, in most cases, the inflammation passes over this, following the course of the superficial vessels and the tendon of the palmaris ongus, and free exit can be given without such an extensive wound.

Tubercular disease of the synovial sheaths of tendons should be treated at first by rest and pressure, in the hope that if all sources of irritation are avoided the tissues may gain the upper hand, and the tubercles undergo retrogressive changes. If this does not succeed excision may be practised with success, even in the case of the compound palmar ganglion. The whole sheath has been laid open from one end to the other, the anterior annular igament divided, and the thickened, softened, gelatinous tissue carefully dissected out as in arthrectomy. The structures are then sutured together n their proper order, an opening left at each end for drainage, and passive motion begun on the second day.

GANGLION

Tendon-sheaths normally contain a small amount of fluid which is practically identical with ordinary synovia. Under certain circumstances, however, its character alters, the quantity increases, and a dilatation like a cyst is formed. Sometimes the whole tendon-sheath is affected; the walls are stretched; the cavity becomes irregular, the weaker parts yielding most; the mesotena and lining membrane are thickened and swollen; the interior is covered over with irregular processes similar to those found in joints; and the fluid is thick, semi-gelatinous, and mixed with thousands of melon-seed bodies formed from the fibrin poured out in the walls. Much more frequently a small pouch is developed, probably as a hernial protrusion through or between the fibrous walls of the sheath ; and this becomes filled with a gelatinous material so thick that, though it can be squeezed out through a cannula, it retains for some time the shape of the bore. In most cases the communication persists, and the diverticulum continues to enlarge, fluid being squeezed into it with every movement of the tendon ; in some, however, it becomes closed, or contracts to such a degree that the two appear distinct. Dilatation of a complex synovial sheath, such as that which surrounds the flexor tendons of the fingers, is known as *compound ganglion* ; when there is merely a cyst developed from one side it is distinguished as *simple or cystic.* Similar cysts, containing the same kind of fluid, although it is usually more liquid, are developed in connection with the synovial cavities of joints, and, particularly when they occur at the wrist, render the diagnosis very difficult.

Causes.—In some instances the formation of a ganglion is sudden, and can be traced to a single strain. More often they appear to result from over-use, or repeated slight injury. Simple cysts are exceedingly common upon the dorsal surface of the wrist, in connection with the extensor tendons, especially that of the second phalanx of the thumb ; but they are met with occasionally on the palmar surface, and though not so often, they are found on the dorsum of the ankle, by the head of the fibula, in the popliteal space, and in short in connection with almost any sheath. Distension of the sheath itself is less common ; the typical example is the compound palmar ganglion ; but it is met with elsewhere, in the fingers themselves for example, limited to the phalangeal sheath, and in the tendons round the ankle.

A simple ganglion forms a round tense swelling, which stands out, white and prominent beneath the skin, when the tendon is put upon the stretch. As a rule they are too small for fluctuation ; many of them feel as dense and elastic as cartilage, but not unfrequently their consistence varies from time to time ; those for example that occur by the head of the fibula are distinctly softer when the knee is bent than when it is extended. They are not painful and there is no sign of inflammation about them, but they may cause considerable suffering from pressing upon a cutaneous nerve ; and very often they are attended by a sensation of weakness, although there is no proof of actual loss of power and no wasting of the muscle.

No definite line can be drawn between these and those that are due to distension of the synovial sac itself. Many of the cystic ones are large, thin-walled, and lobulated, evidently occupying a considerable portion of the general cavity ; and as they grow they become even more irregular in shape. The most important is that which involves the sheaths of the flexor tendons of the fingers (fig. 73). The arrangement of these sheaths is subject to great variety, not only in different persons (arising possibly from different occupations) but at different ages. There is a separate sac for the flexor longus pollicis, which after childhood opens up a communication with the phalangeal one, so that one long cavity extends from the last phalanx to some distance above the wrist. Similarly in the adult there is a common sheath for all the flexors of the fingers, but this opens into the phalangeal sheath of the little one only. In old age, especially in those whose hands have been subjected to much work, the barrier between these two sheaths breaks down, and a very irregular space is left, with numerous septa dividing it into imperfect compartments. According to other observers (Rosthorn in particular) in childhood and frequently in adult life the index and middle finger tendons are devoid of a sheath altogether, and there is but one for the ring and the fifth. However this may be, it is not uncommon as a result of repeated strains to find an enormous swelling filling up the palm of the hand, so that the fingers cannot be closed, extending along the little one, and sometimes the thumb as well, right to the end, and communicating freely with another swelling above the annular ligament of the wrist, reaching upwards for two or three fingers' breadth. If the wrist is flexed and pressure is made alternately above and below, the fluid can be squeezed from one part to the other, and not unfrequently with it numerous melon-seed bodies which can be felt crepitating among the tendons as they pass across. This is known as compound palmar ganglion. It may be caused by a single strain; but in most instances it is of gradual formation. There is no heat or redness, but there is a certain amount of chronic inflammation which leads to the irregular thickening of the walls and mesotena, and to the deposit of the lymph out of which the melon-seed bodies are formed; and occasionally when the irritation is kept up it ends at length in suppuration.

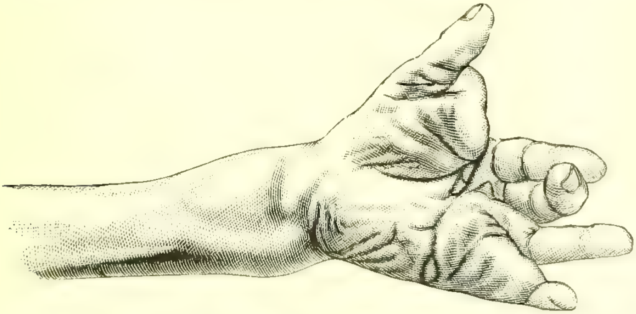


FIG. 73.—Ganglion involving all the flexor tendons of hand and wrist.

Similar changes occur in connection with other tendon-sheaths, the synovial sac of the peronæi for example, or that for the extensors of the toes, but much more rarely.

Treatment.—Cystic ganglion, if it gives rise to any inconvenience, may be treated in various ways. Subcutaneous rupture is often resorted to, but the cyst generally refills, and when it does not it leaves behind a thickening which may persist for years. Puncture with a trocar and cannula is not more satisfactory. Subcutaneous section with a tenotomy-knife, dividing the sac in two with a single horizontal sweep, answers better; but if the cyst causes any real trouble or is unsightly, the most efficient plan is to cut down upon it and excise it. The cure is effectual, and a linear cicatrix only is left. The limb should be placed upon a splint afterwards, until the wound is sound, as not unfrequently the tendon is exposed, and sometimes the cyst communicates indirectly with a neighbouring joint.

Compound ganglion is much more serious, and if the walls of the synovial sac and the septa are thickened and irregular, or if they are covered over with lymph, and the cavity is full of melon-seed bodies, a very guarded prognosis must be given. Pressure is of no use. A free incision may be made into it above and below the wrist, and the whole cavity emptied and drained as thoroughly as possible; but though the fluid is removed, and most of the melon-seed bodies, many are sure to be left, the condition of the lining membrane is untouched, and the drainage is very imperfect. Syme laid the whole sheath open, dividing the annular ligament; and it is a question whether this would not be the best proceeding now, at least for those cases in which melon-seed bodies are present and the walls are much altered in character.

The greatest care must be taken to avoid suppuration. If this occurs, the tendons are almost sure to slough; and if there is the least tension, or if the vitality of the tissues is lowered by the poisonous products of decomposition, it is almost certain to become diffuse and to spread to the wrist-joint, or to the deep planes of cellular tissue in the forearm, and cause the most extensive destruction.

DUPUYTREN'S CONTRACTION

The palmar fascia, and the prolongations of it which run by the side of the fingers and are attached to the periosteum of the first phalanx, not unfrequently become the seat of a peculiarly obstinate form of contraction, tying the fingers rigidly down into the palm of the hand. It rarely occurs under thirty years of age, and is much more common among men than women; indeed, according to some, the latter are entirely exempt, but this is not the case. Usually its beginning can be traced to some slight injury, such as the pressure of a round-headed stick in the palm of the hand during convalescence from severe illness; or a sudden strain, pulling the finger back; but there is no doubt that it is dependent to a very large extent upon gout, although I am not aware that deposits of urate of soda are ever found in it; and it is much more common among the well-to-do than among hospital patients. Certain classes of the latter, however, engineers' fitters for example, are often affected (fig. 74).

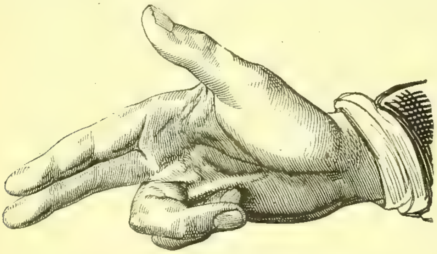


FIG. 74.—Dupuytren's Contraction.

The ring finger is usually attacked the first, but in many cases all the three on the ulnar side are involved more or less; the index only suffers in the worst. The first thing to attract attention is a small hard nodule in the palm of the hand, at a point corresponding to the lowest of the transverse creases into which the skin is thrown and to the interval between the ring and the little fingers. It is not painful unless roughly handled, and does not at first give rise to any inconvenience. Soon, however, the skin begins to waste and lose its flexibility; the fat disappears, and the cutis becomes tied down so firmly to the fascia beneath that it is practically incorporated with it. Then prolongations make their appearance, running from this upwards towards the wrist and downwards to the fingers. The skin becomes adherent in other parts; the bands of fascia stand out more rigidly, and gradually the fingers are flexed and tied down into the palm of the hand n an altogether hopeless way. Extension has not the least influence over hem.

The flexor tendons take no share in the deformity, although at first ight it is easy to mistake the rigid bands that stand out in the hollow of he palm for them. The disease is entirely due to the contraction of the ascia, the deep as well as the superficial layer, and the vertical bands that pass between them and the skin. It affects the fingers on the inner side of he hand more than the rest, because in all probability they are weaker and ess able to stand a strain than the others; and if they are bent backwards he prolongations of the fascia over the metacarpo-phalangeal articulations are tretched and hurt. It is the peculiarly obstinate and progressive character of the contraction that makes it so serious. When once it has commenced t tends steadily to grow worse and worse, tying one finger down after nother; and although in the earlier stages it may be relieved or even cured without great difficulty, in the later ones this is impossible without operation.

Treatment.—Systematic massage, with the finger well extended, will often check the contraction, if not too far advanced, and cause absorption of he inflammatory exudation. If this does not succeed a splint may be worn at night, fitted on to the dorsum of the hand and firmly strapped to the wrist. Little caps of metal are adjusted to the phalanges, and attached to he dorsal splint by means of elastic bands, the strength of which the patient can regulate for himself.

In other cases a more complicated appliance is required. A broad, well-padded metal plate is fitted to the back of the hand and wrist, with exten- ion racks lying over the fingers bent at an angle to suit the degree of lexion. Improvement, however, in this way is very slow, and it rarely happens that patients can be induced to take the trouble before the deformity is too far advanced and the bands too rigid. If the angle of lexion approaches 90° it is almost impossible to straighten it without operation.

Dupuytren himself merely made a transverse incision through the skin nd fascia at the most resisting point, so that when the finger was straight- ned out, a lozenge-shaped wound was left, the sides of which might in suc- essful cases grow together. Modern treatment, however, resolves itself ither into subcutaneous section with a fine tenotomy-knife at many points after Adams); or into a modification of Goyrand's original plan, dissecting ut the whole of the contracted portion. Whatever is done, it must be recol- ected that unless immediate union is obtained the result is likely to be very r worse afterwards than it was before.

When the bands extend far down the sides of the fingers, there is no oubt that Adams's method is preferable. The hand should first be thor- ughly soaked in an antiseptic bath, and well raised, so as to limit the amount f hæmorrhage. The palm is dealt with first, selecting those points where the kin is still movable over the subjacent tissue; then each side of the fingers y itself, as many punctures being made as are necessary to allow them to ome out perfectly straight. The little wounds are then covered up with doform and cotton-wool; a palmar splint adjusted to keep the hand at rest, bandage placed over the whole; and everything left for three days. By at time all the punctures should be healed, and extension may be commenced th an appliance similar to that already described. The more rapidly this is carried out the better; to be successful the fingers should be perfectly straight within the fortnight.

Excision is only practicable where the contraction is of limited extent, and such cases of course succeed the best with tenotomy as well. The incision is made down the length of the band; the skin which is usually very much atrophied and closely adherent, detached from the fascia beneath without bruising; and then the hard contracted band isolated and removed. The advantage of this method is that the straightening is more perfect and the risk of recurrence less; but it is very questionable whether this is real. Certainly some of the cases which have apparently succeeded have relapsed again in an altogether hopeless manner.

Whichever method is adopted the apparatus must be worn at night for some considerable time to prevent recurrence. During the day it may be dispensed with as soon as the fingers are straight. Massage, however, warm bathing, deep friction, and everything that can encourage absorption should be thoroughly practised from the moment that the wounds are sufficiently sound. Nodules and deep bands of the fascia are always left behind, even when the attempt at excision is fairly successful; and every endeavour should be made to promote their absorption, to limit the amount of inflammatory exudation, and to restore as soon as possible the suppleness of the skin.

BURSÆ

Bursæ are spaces developed in the cellular tissue by friction. The deeper ones, lying between tendons and bones, are present at birth, and are lined with a definite endothelium similar to that in tendon-sheaths and joints. Subcutaneous ones, on the other hand, do not for the most part make their appearance until later, and are less regular in shape and structure. Many are constant in occurrence, and are reckoned among the normal structures of the part; but they may be developed anywhere by friction, and throughout life they have a tendency to grow, until in many cases they form communications with neighbouring synovial cavities. The fluid in the subcutaneous ones is more serous than joint synovia, but that in the deeper ones is identical with it.

Bursæ that communicate with joint-cavities naturally possess a special importance. Very often the channel between the two is so narrow that no fluid can be made to traverse it; but where there is the least ground for suspicion, the swelling should always be given the benefit of the doubt, and treated as if it were an outlying part of the synovial sac.

Injuries.—Incised and punctured wounds inflicted with a clean instrument heal readily. The latter are the more serious owing to their tendency to become valvular. Lacerated ones may cause considerable trouble, owing to the fact that the part is the seat of constant friction. For the same reason contusions are frequently followed by slight inflammation. No special treatment, however, is required: if there is a wound it must be thoroughly cleansed and drained; a large extravasation of blood may be aspirated; and in any case careful pressure must be used to prevent tension and to keep the parts at rest.

Inflammation of bursæ.—Simple inflammation is very common. It may be acute or chronic, and subside or end in suppuration. Specific diseases are more rare, but superficial bursæ in particular are liable to be affected in syphilis, gout, and tubercle, probably owing to the frequency with which they are injured.

(*a*) *Acute inflammation.*—This is nearly always due to injury. The symp- ms, if the bursa is superficial, are plain at once. Swelling is very con- picuous ; and redness and local pyrexia are well marked ; but owing to the esence of a cavity in which the exudation can collect, the tension at first not very high, and the pain and constitutional disturbance not severe. In eper ones, on the other hand, the diagnosis is more difficult ; swelling nnot be detected ; the pain is often very great, especially on movement ; d the fever may be such as to lead to the suspicion that other even more portant neighbouring structures are involved.

In these cases the diagnosis often rests almost entirely upon a knowledge the action of the muscles that surround the part. Thus, if the bursa under e deltoid is inflamed, rotation of the humerus is fairly free when the arm is oderately abducted from the side ; in adduction or great abduction it is very inful, owing to the tension upon the sac. So with that under the psoas ; the thigh is flexed the head of the femur rotates without pain. On the her hand, the limb is kept extended when either the bursa between the adriceps and the femur, or that between the ligamentum patellæ and the ia, is affected. In other cases the position of the swelling is the most gnificant sign. If, for instance, the bursa between the os calcis and the ndo Achillis is enlarged there is a swelling on either side behind the limb, t none in front, as when the bone or the ankle-joint is inflamed ; and less the bursa on the front of the femur communicates with the knee-joint ere is no distension of the synovial pouches on either side of the patella, en if it suppurates.

(*b*) *Chronic inflammation.*—This may either be the result of an acute tack, or be chronic from the first. Usually it is caused by some slight but equently repeated injury ; or by a more severe one (a contusion, for example, ling it with blood), the effects of which are perpetuated by constant friction.

The pathological appearance varies very considerably. Sometimes the all is thin and the cavity immensely distended with fluid which at first is blood-stained, but which in urse of time loses its colour and becomes clear and rous. In other cases the wall is thickened (whether ere is fluid present or not) either by the deposit of rin in laminæ on the inner surface or by the forma- on of dense inflammatory tissue around, or by both gether, until it is an inch or more in diameter, and e central cavity is reduced to a cleft (fig. 75). It rely disappears altogether. Not unfrequently the terior is rough and irregular, covered with warty dules or traversed by thickened bands, some of hich, as in the case of the præpatellar bursa, may be the remains of the pta between the different cavities, while others are new formations alto- ether. Occasionally melon-seed bodies are found in numbers, either white, stained with blood, as if they were formed from blood-clot. More rarely ere are definite pedunculated outgrowths with floating cartilaginous ends, milar to those found in joints. This, however, is not common except in teoarthritis, when the bursæ, even though they do not communicate with e neighbouring joint, not unfrequently undergo a similar transformation. inally, sometimes in very old cases calcification takes place.

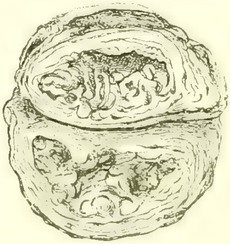


Fig. 75.—Semi-solid bursa laid open.

Tubercular inflammation is characterised chiefly by a slow, painless enlargement, due to the accumulation of fluid mixed with flakes of caseous material. The interior is lined with pale flabby granulation-tissue containing giant cells, but few bacilli. Sometimes, especially in the case of the subglutæal bursa, these cavities attain a very large size and spread for considerable distances among surrounding structures before they break; and then they are prone to leave behind them chronic sinuses covered by flaps of purplish skin. Usually they require the free application of the cautery or of Volkmann's spoon, before they get well.

Syphilitic disease chiefly occurs round the knee and over the tuberosity of the ischium, owing in all probability to the great liability of these parts of the body to injury. The gummatous deposit breaks down, leaving round, punched-out openings with overhanging edges. In gout the bursa that forms over the metatarso-phalangeal joint of the great toe is the one that suffers most frequently, but occasionally deposits of urate of soda are found in the interior of those in other parts of the body.

(*c*) *Suppuration.*—The onset of suppuration in a bursa is usually marked either by a rigor or by a sudden rise of temperature with severe throbbing pain. The swelling rapidly increases in size; the skin becomes boggy and œdematous; and if free exit is not given at once the walls of the bursa give way, the pus spreads far and wide in the softened and hyperæmic connective tissue around, and diffuse inflammation of the cellular tissue follows. In part this is due to the difficulty the pus has in escaping through the dense layer of tissue that has been formed over the cavity by constant friction; in part to the fact that, after all, a bursa, even when it is surrounded by a wall of its own, is only a space in the cellular tissue and is in free communication with all the interstices around. Usually the neighbouring lymphatic glands are involved as well, and sometimes, especially in the case of the bursæ over the olecranon and the patella, the mischief spreads into the bones, and even by direct extension into the synovial cavity of the joints.

Treatment.—Acute inflammation must be treated by rest, cold, and pressure. In most cases it is advisable to place the limb upon a splint, and when the lower one is concerned to confine the patient to bed. If this does not succeed and the swelling does not subside, it should be punctured and the fluid let out, to prevent suppuration.

Simple distension, if the wall is thin, may be treated very successfully by tapping with a trocar and cannula, and applying pressure afterwards; or if the case has not lasted long, and the part is conveniently situated, pressure alone may be tried first. Counter-irritation (the free application of blistering fluid) sometimes effects a cure. The injection of iodine is strongly recommended by some; but the limb must be placed upon a splint, and careful watch kept that the reaction does not go too far. In such cases the walls are probably well-defined, but if the iodine escapes into the cellular tissue, it is not unlikely to cause a considerable degree of inflammation.

When the wall is much thickened measures of this kind are of very little use. It is better, if the bursa is unsightly or causes any inconvenience, to excise it altogether; and this is certainly advisable when foreign bodies are present, unless they can be thoroughly cleared out by free incision.

Deep-seated bursæ are so frequently in communication with neighbouring joints, especially when they become enlarged, that very great care is required in dealing with them. The most treacherous of all, perhaps, is that which appears sometimes along the inner border of the popliteal space. When the knee is extended it forms a firm elastic swelling, owing to the tension of the semi-membranosus and the inner head of the gastrocnemius between which it lies. In flexion, on the other hand, it is so soft and flaccid that it can scarcely be felt; but neither in one condition nor the other is it possible to prove or disprove whether it has a communication with the joint. Fortunately in these deep-seated bursæ the more serious consequences, such as the formation of loose bodies and suppuration, are of rare occurrence; but even chronic distension causes a very unpleasant sense of weakness and greatly impairs the utility of the limb. Sometimes, moreover, as they grow larger they approach nearer the surface (the pressure in their interior increases in proportion to their size), and then, like the synovial diverticula they so much resemble in structure, they may either point beneath the skin and be opened by mistake, or may actually cause it to rupture and give way. In cases such as these aspiration and pressure should be tried first; but if these fail, and the cyst is accessible, it is better to cut down upon it, excise it, and stitch the neck up with catgut than to resort to measures calculated to excite inflammation.

In the case of suppuration free incision, as soon as possible, is the only course. Very often more than one is necessary, and not unfrequently, especially in the case of the knee, they must be made some little distance from the actual bursa, down by the side of the limb, so as to tap the cavity at its lowest point. Recovery in such cases is always exceedingly slow. Sloughs of fibrous tissue often have to separate; the skin is extensively undermined; the part, even in the case of the knee-joint, is very difficult to keep at rest; matter will collect in outlying pockets which have to be drained; and even when recovery is apparently ensured, not unfrequently, as soon as the joint is used, some of the old cicatrices break down again. If the suppuration has extended to other structures—if, for example, the bone beneath is exposed and carious—repeated operations may be required before it is sound enough to stand friction and pressure.

CHAPTER VI

INJURIES AND DISEASES OF BONES AND JOINTS

SECTION I.—MALFORMATION AND DEFORMITIES OF THE LIMBS

DISPROPORTIONATE GROWTH

OVERGROWTH, involving either a limb or one part of it only, is not uncommon. The condition is present at birth, but naturally becomes more noticeable as age advances. One foot may be many times larger than the other, or one or two toes only; one or two fingers in each hand may grow until they are three or four times the natural size, and occasionally this is almost symmetrical.

On the other hand, there may be congenital absence of the whole or part of one of the bones; the radius, for example, may be wanting, or the tibia or fibula, causing very severe distortion of the foot or hand as the case may be, and associated occasionally with defect of the corresponding digits; or one end may be developed and not the other. Deformities of this nature are, as might be expected, often associated with other defects, mental as well as bodily, but they occur as well in people who are in all other respects well formed and well developed.

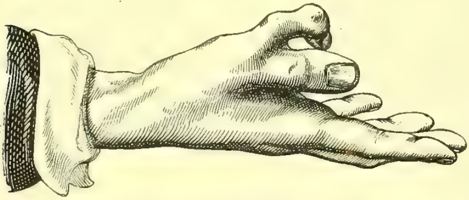


FIG. 76.—Supernumerary thumb.

Supernumerary fingers and toes are occasionally met with, particularly in connection with the thumb. If they are merely attached by a pedicle of skin, it may be divided at once; but in all other cases a careful examination should be made first, as not unfrequently the synovial membrane of the joint that belongs to the supernumerary finger communicates with that of the normal one (fig. 76).

CONGENITAL DISLOCATION

This name has been given to a peculiar deformity, which is of common occurrence at the hip-joint, and is occasionally met with elsewhere. Instances of it have been recorded in connection with the shoulder, knee, ankle, elbow, wrist, and even the lower jaw; but in many of these other even more grave defects were present as well. Like similar deformities which do not involve joints, it may exist in many grades; it is rarely noticed at birth, and it becomes more and more marked so long as the period of growth lasts.

The chief interest is in connection with congenital dislocation of the hip-joint. The limbs at birth appear well developed and in most cases there is o suspicion that anything is wrong until the child is a twelvemonth old; ossibly there is slightly greater difficulty in abduction than usual, but not ufficient to attract the nurse's attention. Walking, however, is unaccount-bly delayed, and even when the child begins to move about, its action is xceedingly awkward and insecure. On examination it is found that there s an unusual prominence in the glutæal region, that extension and abduction re unduly limited, and that the head of the femur can be made to slip up nd down upon the dorsum ilii.

When the child at length does walk, the deformity, provided the affection s bilateral, is exceedingly characteristic. The normal rounded shape of the lutæal region is lost, the trochanters are pushed up far beyond their proper evel, and form a great projection over the ilium; the basis of support for he pelvis is shifted backwards, the front part of the body projects, the houlders are thrown back, and in other words there is extreme lordosis with n unusually protuberant abdomen. In many instances this is associated vith considerable inversion of the limb, and flat-foot.

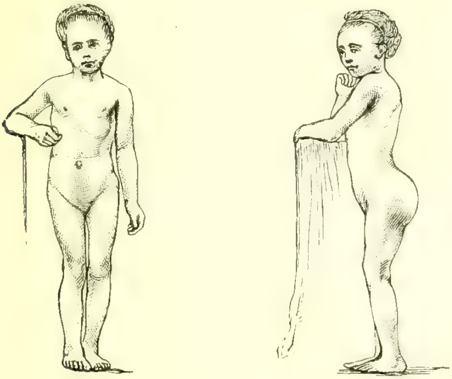


FIG. 77.—Congenital displacement of both femora.

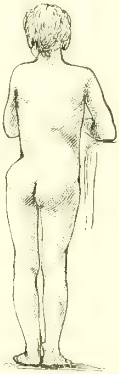


FIG. 78—Congenital displacement of head of left femur.

If one side only is affected the deformity is even more conspicuous, owing o the difference in length of the legs, and consequent tilting of the pelvis nd lateral curvature of the spine. When the child is lying on its back the nalformation is much less distinct, and at first at least the head of the femur an be drawn down nearly to its natural situation (figs. 77 and 78).

Formerly this was attributed to traumatic dislocation occurring at birth, nd it was pointed out in support of this view that it was much more com-non in breech presentations than in others; and that the extreme shallow-ess of the acetabulum would undoubtedly favour it. Without, however, enying the possibility of such an occurrence (in one or two cases a distinct lip has been felt at the time), there can be no doubt that this is not the rdinary cause. It is very doubtful whether it is really more common in hese presentations; in the majority of cases the birth is described as having een particularly easy; the affection is often bilateral, it may be hereditary, nd it is seven or eight times more frequent in female children than in male.

Opportunities of examining the interior of the joint are not common, nd in all the cases hitherto the patients have either been adults or at least have walked for some time, so that secondary changes had developed. There is, however, a fair amount of agreement among them; the iliac portion of the acetabulum is wanting, either altogether or in part; the cavity itself is very small and triangular in shape; it may be lined to some extent with cartilage, but it is much too shallow to accommodate the head of the bone. The ligamentum teres is usually present (its occasional disappearance is probably secondary); the capsule is strongly developed and contains the head of the bone, although of course it is immensely stretched. The upper extremity of the femur is rather smaller than natural, somewhat flattened, and rests in an imperfect socket upon the dorsum. The lower part of the innominate bone is narrow and elongated, the ischial tuberosity everted, and its ramus twisted; and the glutæi muscles (especially the maximus), are usually considerably wasted.

It is possible that this may be caused by extreme distension of the synovial sac *in utero*; there is no doubt that, even when the head of the femur fits much more securely in its cup than it does at that period of life, dislocation within the capsule can be produced in this way, the fluid penetrating between the articular surfaces until it separates them from each other; and it is also true that reparative processes are carried to a much greater extent of perfection in intra-uterine life than afterwards; but certainly for the majority there is no more evidence in favour of this view than there is in favour of traumatic dislocation. Sometimes it is associated with what has been called genu recurvatum—hyper-extension of the knee, caused by fixed malposition *in utero*; but there is no proof that this is present in ordinary cases.

In comparison with this, congenital dislocation of other joints is exceedingly rare, that of the humerus being perhaps the most common.

The diagnosis rarely presents any difficulty. After acute epiphysitis in infants the limb sometimes assumes the same position and direction, owing to the head of the bone having been destroyed; but the history and the cicatrices are sufficient evidence.

Treatment.—It rarely happens that this deformity is detected until some considerable time after birth, so that even if it were due to traumatic dislocation during parturition any attempt at reduction would be futile. In the vast majority of cases little or nothing can be done for it. Continued extension, however, kept up for a twelvemonth or even longer, has been followed by improvement more or less permanent. In other cases, pelvic bands and supports of various kinds have been worn to transfer some of the weight directly on to the trochanters either by vertical or circular pressure, but such accurate and at the same time constantly varying adjustment is required that it is very doubtful if any real benefit is conferred. In the worst cases (and they differ very much in severity) Ogston recommends the formation of a new cavity in the proper situation, and dovetailing the femur into it.

If it is unilateral a high boot must of course be worn, to obviate twisting of the pelvis and lateral curvature of the spine.

CLUB HAND

A distorted and deformed condition of the hand is occasionally met with at birth consequent on defective development of one of the bones of the forearm. Very rarely it is due to muscular rigidity or contraction of the palmar ıscia. In a few cases a certain amount of benefit is obtained by tenotomy ıd the use of splints; but in the majority it is beyond remedy.

WEBBED FINGERS AND TOES

In this malformation the double fold of skin which should be limited to ıe angle between the digits is prolonged downwards along the sides until in ome cases it reaches the whole length (fig. 79). Very often it is symmetrical, ıd sometimes, in the worst cases, all the fingers are united.

Division is apparently a simple matter, but unless proper precautions are ıken reunion from the angle onwards is almost sure to occur. It has been ecommended to make a hole through the web as far back as possible and ısert a metal ring, in rder that thorough cicarisation may take place rst, and then the rest can e divided without fear, ut if there is sufficient hickness of tissue a plastic peration is preferable.

In one fashion (that of)idot) an incision is made long the dorsal surface f one finger and the almar of the other, and he flaps of skin so marked ut are reflected towards each other until they meet in the middle. The division is then completed, and the flaps carefully wrapped round and sutured in osition, the dorsal one, for example, reaching round to the palmar surface f the same finger and *vice versâ*. This, however, is rarely practicable unless here is a good thickness of tissue available, and the longitudinal cicatrix unning down the middle of the palmar surface of one finger is not unlikely o lead to a very obstinate variety of contraction.

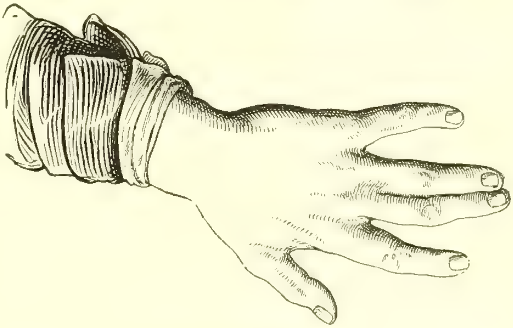


FIG. 79.—Webbed fingers.

In Agnew's method a dorsal flap, triangular in shape, is cut from the pper surface of the web. The apex corresponds to the free margin, the base o the interval between the proximal ends of the first phalanges. This is eflected backwards on to the dorsum of the hand, the rest of the web divided s far back as necessary, and then it is folded over, in between the fingers, o as to fit into the gap. The edges, both of the reflected flap and of the ounds down the sides of the fingers, must be sutured accurately so as to nsure primary union.

CONGENITAL TALIPES

There are three primary varieties of this deformity.

1. *Talipes equinovarus.*—The heel is raised, the inner edge is drawn upards, and the sole is twisted inwards so that the patient stands upon the ıter side of the foot, or in extreme cases upon the dorsum and the outer ıkle (fig. 80).

2. *Talipes calcaneus.*—The toes are raised and the heel depressed, so that ıis part only of the foot is brought into contact with the ground.

3. *Talipes valgus.*—This is the opposite to varus, the foot being so twisted that the outer side is raised and the patient walks upon the inner ankle. Occasionally it is associated with equinus or calcaneus (equinovalgus or calcaneovalgus), but it is very much more rare than the others (fig. 81).

Congenital absence of the tibia or the fibula gives rise to a form of talipes, which must not be confused with the preceding, in which all the bones are present.

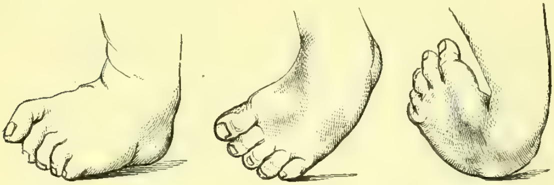


Fig. 80.—Congenital varus. Three grades of severity.

Causes.—Congenital talipes in the vast majority of instances is merely an arrest of development with persistence of growth, similar to cleft palate and other malformations. The parts retain the relative position that is natural to them at different periods of fœtal life, slight modifications following as the size of each increases.

The cause of the arrest is unknown. In exceptional instances it may be due to pressure, as suggested by Parker and Shattock, the foot being confined in some irregular position, so that the natural evolution of the limb cannot take place, just as genu recurvatum can be produced in the fœtus by persistent extension of the knee; but in the majority no evidence of such confinement exists, the parts are as well grown (in point of size) and the skin as natural as in ordinary feet.

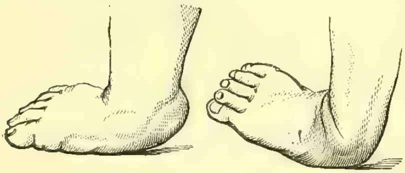


Fig. 81.—Congenital valgus.

Like other malformations, it is not unfrequently hereditary, and often descends in the father's line. In a certain proportion of cases it is associated with spina bifida and other defects, and on this the argument has been based that, because they occur together, one is the cause of the other. The muscles and nerves going to the part have been examined many times, but in nearly every instance their structure has been perfectly normal, and, with the above-mentioned exceptions, the same may be said of the spinal cord.

Pathology.—In talipes equinovarus the foot retains the position it assumes about the sixth week, when the hip and knee are flexed and the feet meet over the lower part of the abdomen and cross each other. In talipes calcaneus the deformity is much later, dating from the time when the feet are bent upwards with the dorsum resting against the front of the leg, and the normal unfolding of the part is not interfered with. The earlier the date at which the arrest takes place, the worse the deformity.

The chief change is in the astragalus, and particularly in the obliquity of its neck, which retains the direction that is normal in anthropoid apes. This is measured (Parker and Shattock) by means of two threads stretched over the bone when placed upon a horizontal surface. One passes from before backwards over the middle of the trochlea, at right angles to its transverse diameter; the other along the outer edge of the neck. The angle that the two make with each other in front is the measure of the deviation. In adult specimens the mean was found to be 12°; in the fœtus at full time 35°; in varus 49°; and in a young orang 45° (it is less in the adult). In other ords, although the difference in the various specimens was considerable. hese observers found a regular gradation from the earlier periods of life to he later, and showed that the deformity in talipes varus was the worst, in alipes calcaneus much less. The position of the internal malleolar facet, hich runs nearly as far forward as that for the scaphoid in the fœtus at ll term and the anthropoid apes, may also be taken as an indication of he obliquity; in the former it recedes, in the latter it persists, though not quite such a marked degree.

Defective development of the lower limbs is exceedingly common in hildren at birth. The hips and knees in many infants cannot be straightened ut for months; and the feet, although they can readily be brought into the roper line, and by degrees come to it of themselves, in the vast majority ssume naturally the position of varus. In others there is a certain degree f calcaneus, which, however, unless it is associated with other troubles, early always disappears spontaneously. With regard to this latter deformity, s it does not appear, like talipes varus, to have a persisting representative mong the lower animals, it may possibly be due to the accidental retention f the foot in one position; and perhaps this may account for the fact that it rely requires much treatment. If this really is the case there is a very istinct difference in origin between the two, the one being due to retention f a normal developmental condition, the other of what may be considered n accidental one, acquired late in the evolution of the race.

The amount of distortion in the common forms varies very considerably, nd is immensely exaggerated if the child is allowed to bear its weight upon he foot in the deformed position. The tuberosity of the os calcis is drawn pwards until its direction is almost vertical; and at the same time it is otated on its longitudinal axis until the greater process rests upon the round. The astragalus is tilted forwards, almost out from its socket, and s neck twisted even more. The scaphoid is drawn up to its inner side, aving the front articulation and forming another for itself between the stragalus and the internal malleolus, while the cuboid is so twisted round hat its dorsal surface may even rest upon the ground. The outer border of he foot becomes convex downwards from the heel to the toes, the inner order is much shortened. The head of the astragalus is divided into two arts, an outer subcutaneous and an inner, almost at right angles with it, r the scaphoid; and the external malleolus is pushed far back, beyond the vel of the internal.

The inferior calcaneo-scaphoid, and the anterior and middle parts of the ternal lateral ligament of the ankle-joint are very much shortened; the nds on the outer side, on the other hand, are stretched; and the tendons the anterior and posterior tibial muscles are brought close together.

In the worst cases, those which have been neglected or have relapsed, e whole foot is shortened and stunted, the weight is borne upon the boid, the external malleolus and the outer side of the anterior end of the calcis; an enormous bursa or callosity is developed, covering the whole rface; and the metatarsal bones are so squeezed together that the transrse arch of the foot is narrowed, and a deep longitudinal furrow formed in e sole.

Analogous changes, but, as a rule, much less marked, are present in ipes calcaneus and in the rare form of congenital valgus.

Treatment.—There are three different sets of obstacles, the tendons and the plantar fascia; the ligaments, especially the anterior portion of the deltoid, which holds the scaphoid close against the internal malleolus; and the bones, which have not assumed their normal shape and relation to each other. Of these the first two may be stretched or divided, according to the amount of contraction they present; the last can only be influenced by steadily continued pressure. Fortunately, in the case of infants, this acts with especial rapidity (as may be seen in neglected cases, or in the pathological facets that form in genu recurvatum); and if only the treatment is begun sufficiently early, and continued with sufficient persistence, the soft and yielding cartilages soon mould themselves into the normal outline. If the treatment stops short of this, relapse is sure to occur; and with each month it becomes more and more difficult to effect a change, until at length, when the bones have become hard and dense, it becomes a question whether some other plan should not be adopted.

Slight cases are treated by manipulation. If the foot comes easily into the proper position, and the muscles are well nourished, it will assume the normal position in course of time with very little assistance. The joints should be thoroughly worked and rubbed every night and morning, taking care that the foot is in plantar flexion when eversion is being practised; and all that is needed is perseverance.

When this does not succeed, and yet there is no great degree of rigidity, the foot may be twisted into the proper position, and fixed by means of a splint or plaster bandage, until the bones have grown into the normal shape. A flannel bandage is applied first, from the foot to above the knee. An outside metal splint (either of tin or zinc) is then fixed along the limb and the foot drawn out to it (still in the equinus position); or a plaster bandage placed over it, and the limb held as near the normal as possible, without using too much force, until it is firmly set. A splint must be removed and reapplied at least every second day, the skin being thoroughly well rubbed and sponged with spirit and water each time, so that there may be no redness; a plaster bandage may be left for a week, but it is not advisable to leave it longer. As soon as the varus is thoroughly corrected (or, better still, a little over-corrected, for it is sure to relapse somewhat) the equinus may be attended to; the object of leaving it is to give a better purchase for the bandage, and to allow the anterior part of the tarsus and the os calcis to move freely upon the astragalus. Nearly the whole of the inversion and eversion of the foot takes place at the calcaneo-astragaloid articulation, very little at the mid-tarsal, at least on the outer side.

In every case it is essential to make sure first that the varus is real. In many instances of apparent equino-varus one half of the deformity disappear as soon as the gastrocnemius is thoroughly relaxed; the traction of th tendo Achillis has caused equinus, and the natural tendency to inversion when there is nothing to prevent it, has led to the semblance of varus. I both are present, the equinus should be left to the last.

A combination of these two plans is very successful; a strip of meta being placed next the flannel, running up the side of the leg and under th sole of the foot, with a few turns of plaster bandage over it. Just before th plaster sets the foot is twisted outwards a little and left. Careful watc must of course be kept upon the circulation in the toes.

In a very large proportion of cases this treatment, if persevered in, su ceeds admirably; but in the worst, in which the sole of the foot is inverte nd deeply furrowed, and the muscles and tendons stand out rigidly, omething further is required.

The plantar fascia, the anterior and posterior tibial tendons, and someimes the tendon of the flexor longus digitorum, may require division; ut *the only rule is to divide all soft tissues that stand out tensely and revent rectification.*

Tenotomy.—Tendons and ligaments should be divided subcutaneously. small puncture is made in the skin with a tenotome opposite the proposed eat of section (which, other things being equal, is the spot at which the endon is thinnest and stands out most prominently); and either the same nstrument or a similar one with a blunt point is passed with its blade on he flat behind the tendon (as a rule) while the assistant holds the limb n such a way as to relax the structures to be divided. As soon as it has assed a sufficient depth, the blade is rotated through a quarter of a circle nd the cutting edge brought against the tough fibrous tissue, the assistant neanwhile changing the position, flexing or extending as the case may be o as to make everything tense. Then, with a gentle backward and forward novement, the fibres are cut through in successive layers, giving a kind of risp sensation to the hand, until the resistance gives way. The separation hould be distinctly felt, but there should be no jerk, for fear of sending the nife through the skin. As a precaution the finger of the other hand should e pressed upon the surface in order that the presence of the blade may be etected as the skin is approached.

In other cases, if it is close to the insertion of the tendon, the knife is assed between it and the skin and the division practised in the opposite irection. Recently the plan of open section has been advocated on the round that it is more thorough and complete without being more dangerus; but it is questionable whether the supposed advantage this possesses is ufficient compensation for the time the wound takes in healing, even if here is no more risk.

Wounds inflicted with a tenotomy knife are dusted over with a little odoform and covered with a piece of lint or cotton-wool and a bandage. As rule their site can hardly be detected on the fourth day, and suppuration is nknown. The tendon unites, like all other tissues, by the organisation of ascular granulation-tissue, springing chiefly from the sheath and the tissues round; itself contains so few blood-vessels that, like compact bone, it takes t first but little share in the proceeding; after a time it, too, becomes nore vascular, and then the tissue that lies between the ends slowly shapes self into the fashion of the structures it joins, and the tendon and its heath are thoroughly restored. It is a matter of very great importance, so r as the immediate treatment of talipes is concerned, that this process of epair is practically independent of the distance between the ends, so long s it is not extreme.

The central and inner parts of the plantar fascia often require division, metimes in more places than one: it is best accomplished by slipping e tenotome between the skin and the fascia and cutting towards the deeper ructures. The tendinous part of the abductor hallucis may be cut at the me time by introducing the tenotome just in front of the inner tuberosity the os calcis and cutting down to the bone.

The posterior tibial, the one that usually comes next, lies almost in the id-point (from front to back) of the leg, just above the internal malleolus.

Here it can be easily divided by making a puncture with a sharp-pointed tenotome right down to the tibia, withdrawing it, and passing a blunt-pointed one along its track (with its blade parallel to the leg) until the posterior border of the bone is felt. Then the tenotome is turned round, and the tendon that lies next to the bone, immediately behind it, divided, while the assistant forcibly everts the foot. If the incision is carried a little too far, the tendon of the flexor longus digitorum is divided as well; and, if farther still, the posterior tibial artery. The hæmorrhage may, however, always be stopped by means of a pad and a bandage.

In Syme's operation the tendon of the posterior tibial is divided just behind its insertion into the scaphoid, below and in front of the internal malleolus, against the bone; and if, as in many cases of club-foot, the anterior and middle bands of the internal lateral ligament require section as well, preference should be given to this.

The anterior tibial presents much less difficulty, as it can always be felt in cases of club-foot standing out distinctly. The points usually selected are either immediately above its insertion, cutting down on to the bone: or higher up where it is prominent on the inner side of the front of the ankle-joint.

The tendo Achillis (unless the case is equinus without varus, or with only the appearance of it) should be left until the foot is in a perfectly unfolded condition, in a right line with the leg. As soon as this is accomplished it may be divided and the foot brought up.

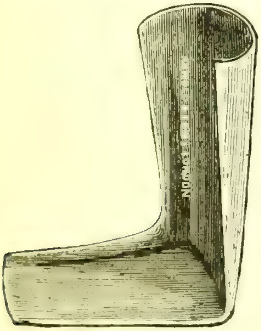
The usual point is opposite the narrowest part of the tendon, not more than an inch above its insertion, in an infant. The foot is held by an assistant (the patient lying on the face) in a position of moderate plantar flexion; a puncture is made with a sharp tenotome on one side or the other, according to convenience, and the blade of the instrument (parallel to the limb) pushed on until it can be felt under the skin, upon the opposite side. It is then turned round, the foot bent up towards the front of the leg to make the tendon tense; a finger of the left hand placed on the skin over it; and the fibres gently divided rather by the pressure of the blade than anything else. Care must be taken that there is no jerk at the end.

Division of the ligaments.—Recently Parker and others have strongly advocated division of all resisting bands, especially the shortened and rigid ligaments on the inner side of the foot. A curved tenotome with a short cutting edge is entered just in front of the anterior border of the internal malleolus, passed carefully, flatwise, between the ligaments and the skin; and then by a gentle sawing action made to divide everything down to the bone. The foot must be rotated out by an assistant, so as to separate the malleolus as far as possible from the sustentaculum tali and the scaphoid. The same instrument is then gently pushed forwards, close to the bone, on the plantar aspect, so as to divide the calcaneo-scaphoid ligament, and the tendon of the posterior tibial. The long and short plantar bands are cut through from the outer side. A straight tenotome is passed in opposite the calcaneo-cuboid articulation (almost, sometimes, on the sole of the foot), and carefully pushed inwards, close to the bone, dividing the ligament as it goes.

After tenotomy.—Until recently it was always recommended that when the punctures were dressed the foot should be carefully enveloped with a flannel bandage and secured to a light splint made of flexible metal, in the faulty position. It was feared that inflammation might set in, or that the ends of the tendons might be so far separated that union would not take ace between them. In five or six days, when the little wounds were sound, e splint was removed and an extending apparatus applied in order to retch by slow degrees the lymph poured out between the cut ends. Parker, wever, has clearly shown that there is absolutely no foundation for this; at the displaced position may be rectified at once with perfect safety; and at the long and tedious plan of treatment previously followed may be effecvely supplanted by a much more rapid one. Thomas employs a footrench, the prongs of which are covered with rubber, for the purpose of ducing deformity as rapidly as possible.

If this method of rapid reduction is adopted all the tendons and ligaments at resist and stand out when the foot is brought into the right position are vided; the punctures sealed with iodoform and a carefully picked layer of tton-wool; a flannel bandage applied from the toes upwards; and then, hile the assistant holds the foot in as good a position as possible, a plaster ndage placed over the whole. This is left for a week: at the end of that me it is taken off, the skin thoroughly rubbed and a fresh casing put on, essure being used as before to twist the foot outwards into the normal line. he advantages of this plan over the old one are obvious at the first glance. may be commenced at once, within a few days of birth, at a time when y appliance such as Scarpa's shoe or a metal splint is practically out of the estion; it avoids the evil effects of local pressure upon the skin, which ly too often, when the older plan was followed, rendered it necessary terrupt the treatment for days or weeks together; it is carried out during e period when developmental changes are most active; the longer the case left, the more difficult the deformity is to rectify; and it effects a greater gree of improvement in weeks than the former plan did in months. As a le, unless the case is very severe, the foot is practically unfolded by the end the fourth or fifth week.

Phelps adopts the same method, but divides everything in an open wound. n incision an inch or two in length, according to the age of the patient, is ade downwards from just in front of the tip of the internal malleolus, and verything, tendons, fascia, ligaments, nerves, and, if they are in the way, essels divided down to the bone. Esmarch's bandage is used and the limb



IG. 82.—Tin splint for slight cases in infants.

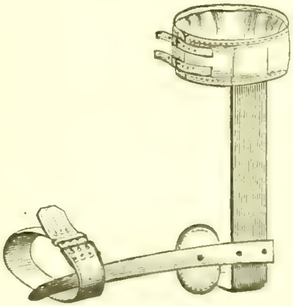


FIG. 83.—Little's shoe for slight cases of varus.

aised afterwards, the wound being covered with protective and enveloped in bsorbent dressings. In old cases the neck of the astragalus is divided too.

As soon as the deformity is thoroughly corrected the splints are left off during the daytime, and the feet exercised at least twice a day, the skin well rubbed, the muscles kneaded and all the joints worked; but some appliance is required at night until the tendency to relapse has disappeared—until, that is to say, the shape of the bones is definitely changed. For infants a light tin splint is sufficient; it consists of a trough for the leg; a foot-piece at right angles with it, and a little everted; a soft leather strap to keep the ankle down, and two webbing ones to maintain the position of the leg and foot respectively (fig. 82). For older children the same appliance made of stouter metal, thin sheet iron for example, may be employed, or Little's (fig. 83) or Scarpa's shoe. The latter is formed of a leather slipper with a leg-iron, and a well-padded leather strap to fit round the calf. Opposite the ankle is a cog and ratchet arrangement in order to alter the angle as required; and attached to the outer side of the sole-plate is a metal spring by which a certain degree of eversion can be secured. The foot is fixed in position first, the heel being held down by a strap passing over the front of the ankle; the calf-piece buckled, and then the sole-plate brought to the required angle with a key (fig. 84).

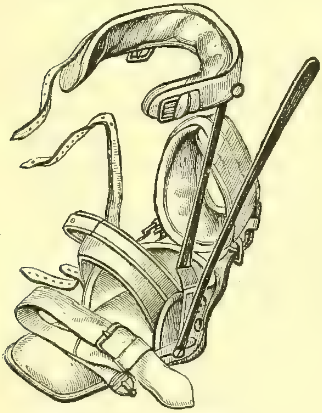


FIG. 84.—Little's modification of Scarpa's shoe for talipes.

In older children, especially in those cases which have either never been treated at all, or, what is nearly equally bad, have been allowed to relapse, a properly made boot with an outside iron and a calf-piece must be worn for a very considerable time after reduction, often for years, or the deformity is almost certain to return. If there is any inward rotation at the knee, the irons must be carried up the limb and fixed to a pelvic girdle (with a proper arrangement of joints) to prevent relapse effectually.

Tarsectomy.—A perfectly hopeless form of club-foot is occasionally met with in children and young adults. Tenotomy has been performed time after time without any permanent benefit; the bones are hopelessly distorted and peculiarly hard, the ligaments shortened, the muscles wasted, and the limb comparatively useless. For such as these there is no alternative but amputation, giving them a stump to walk on (which is better than walking on the dorsum of the foot), or tarsectomy, removal of a portion of the tarsus, so that the sole may be brought down to the ground again. Various forms of this operation have been devised, but the two that answer the conditions best are excision of the astragalus, and the removal of a wedge-shaped portion of bone (taken chiefly from the cuboid and those on either side of it) from the outer border of the foot.

Excision of the astragalus is performed through a longitudinal incision on the outer side of the foot, between the tendons of the extensor longus digitorum and the peroneus tertius. The articulation between the scaphoid and astragalus is exposed, and the dorsal astragalo-scaphoid ligament (which may be much thickened) freely divided. The anterior end of the foot is then twisted so as to separate the astragalus from the surrounding bones; the anterior fasciculus of the external lateral ligament of the ankle-joint cut through, and a stout, sharply curved hook with a cutting edge on its concave surface passed between the os calcis and astragalus until it reaches the posterior extremity of the interosseous band. This must be cut through by steady traction, and then the astragalus is so nearly free that it may almost be tilted out of its socket by forced plantar flexion. The wound is treated in the ordinary manner, the foot being secured at once at right angles to the leg with the sole in the proper position.

Excision of a wedge-shaped portion from the outer border of the foot is preferable if the varus is the more prominent. An incision, convex downwards, is made along the outer border of the foot from the middle of the metatarsal bone of the little toe to the os calcis; the soft parts, tendons, arteries, &c., are carefully lifted off from the dorsal surface, and the peronæi if possible pulled to one side. Then a wedge-shaped mass of bone, corresponding in size and shape to the deformity that is present, is removed with a chisel or with Adams' saw. The base of the wedge faces the upper and outer border of the foot; the apex points inwards, while the sides slant down towards each other, so that the under (plantar) surface is much smaller than the upper. In actual practice the part removed is rarely so geometrical; roughly it corresponds to the cuboid with a varying amount of the neighbouring bones; the essential point is that it should be of sufficient size to enable the foot to become straight and lie flat. Afterwards the wound is thoroughly cleansed, drained if thought advisable, covered with an absorbent antiseptic dressing, and fixed with a plaster bandage. How long it should be left depends upon the patient's temperature, and whether a drainage-tube has been used or not.

Fitzgerald, in old cases, divides all the tendons, including the tendo Achillis and deep ligaments down to the astragalo-scaphoid articulation. He then makes an incision on the outer side of the foot from above downwards behind the calcaneo-cuboid articulation, passes a chisel in front of the ankle-joint, down to the neck of the astragalus, divides this, the os calcis and the scaphoid; and forcibly moulds and wrenches the foot into shape. A splint with a foot-piece is used to retain it in position afterwards. Photographs of the cases certainly show an excellent result.

These operations undoubtedly enable the foot to be brought into a better position, and are infinitely preferable either to amputation or to progression upon the dorsum with the great toe projecting upwards, a condition not uncommon among relapsed cases; but the necessity for them would not arise if they were properly attended to in infancy.

Acquired Talipes

Club-foot, apparently resembling the congenital variety, but in reality differing from it in many essential particulars, may be caused by infantile paralysis, spasmodic muscular contraction, fibroid degeneration of muscles consequent on inflammation or injury, and cicatrices following burns; or, again, it may be secondary, as when talipes equinus develops in hip disease owing to the shortening of the limb. Of these the most important and the most common is the first.

1. *Talipes due to Infantile Paralysis*

In congenital club-foot the essential lesion is an arrest of development; the bones, ligaments, fasciæ and muscles all take part in it. In talipes due to infantile paralysis the muscles alone are in fault at first, the bones are well developed, the fasciæ and the ligaments are not tense, the sole cause is the loss of power of one or more muscles or groups of muscles. Secondary changes, however, take place in this (unless means are taken to prevent them) just as they do in the congenital form. The opposing groups of muscles, having lost their antagonists, gradually become shortened and rigid; the bones from constant pressure become altered in shape, and even sometimes the ligaments contract (possibly owing to local inflammation, for as a rule they remain quite lax in other joints). The result is that, although the diagnosis between the two varieties is exceedingly easy, so long as the case is recent (in the one the foot can be placed at once in its natural position, in the other it cannot), it may become difficult in the later stages, unless there is a history of the deformity having been present at birth. Other symptoms of infantile paralysis render it of course practically definite; if the limb is cold and wasted, liable to chilblains, and smaller than the other in all its dimensions, the question may be regarded as settled; but the presence of one complaint cannot logically be regarded as conclusive proof of the absence of another.

Varieties.—These are the same as in the congenital form, but there are certain points of difference. Talipes equinus, for example, often occurs by itself; indeed it is the most frequent of all, though mixed and irregular forms are not uncommon. Every grade is met with, from paralysis of all the muscles of the limb with extreme distortion, to a loss of power that is scarcely perceptible and confined perhaps to a few fibres of a single muscle. As a rule it comes on about the second year, but it may not occur until much later; on the other hand, in cases of rickets, it may be present before the child begins to walk, so that the defect is often believed by the parents to have been present at birth (fig. 85).

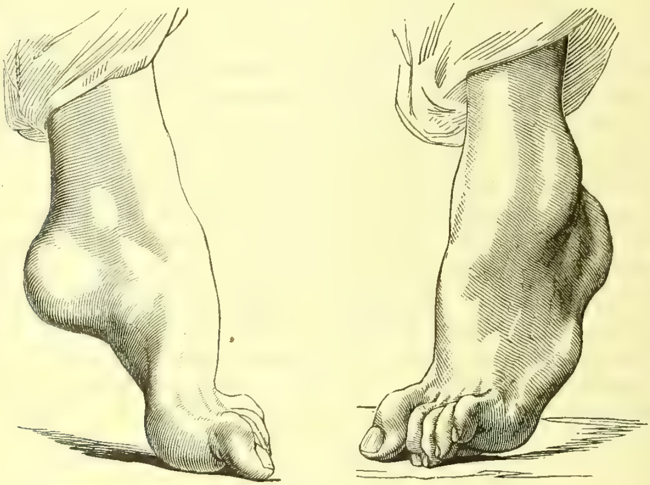


FIG. 85.—Talipes equinus.

Talipes equinus results from paralysis of the extensors on the front of the leg. If all are involved equally the foot remains straight; if the tibialis anticus retains any power the inner side is raised and the sole looks inwards.

In the worst form of infantile paralysis, when the loss of power is complete, the whole foot drops forwards, the heel becomes almost vertical, and the astragalus rolls forwards from under the tibia until the dorsum drags along the ground. The whole extremity is atrophied and cold, the bones fail to grow, the skin is constantly liable to chilblains, and chronic ulcers make their appearance every winter. If the gastrocnemius escapes the heel is dragged up and after a time becomes fixed, with usually a certain degree of varus, owing to the natural tendency of the foot to assume that position when at rest. Nearly always, however, when the mischief is so extensive as to involve all the muscles on the front, the gastrocnemius and the deep flexors suffer too, not perhaps so severely, and the paralysis being general, fixed displacement does not follow.

In those not quite so bad when the loss of power in the anterior muscles is only partial, the chief displacement usually occurs at the mid-tarsal joint, the ankle itself being less affected. The scaphoid and cuboid are drawn downwards and backwards, and the head of the astragalus is left projecting on the dorsum almost uncovered. After a time this becomes permanent, the ligaments and fascia on the plantar surface shortening and growing rigid. In some instances the sole of the foot is so much contracted that the anterior half is almost if not quite at right angles with the posterior, the heel is raised completely off the ground, and the weight borne on the ends of the metatarsal bones. In others, probably when the interossei and the short flexors of the great and little toes are involved, this is associated with a peculiar claw-like condition of the foot, the proximal phalanx being over-extended, the distal ones flexed.

In the milder forms when the paralysis is temporary only (as after diphtheria) the distortion is very slight; the heel is merely a little raised, and the sole of the foot a little shortened (*talipes arcuatus*); but if it continues long enough for contraction of the fascia to take place (*talipes plantaris*) it may prove the source of great inconvenience; the gait is awkward, there is great pain on standing, corns form beneath the metatarsals, reflex muscular spasm is not uncommon, and active exercise is very difficult. The diagnosis can be made at once by comparing the impression left after standing with that of the opposite foot; the arch is shorter, very much less of the sole comes into contact with the ground, and the outer part of the tread in particular is narrowed. In long-standing cases the contracted bands can be felt standing out on the inner side of the sole.

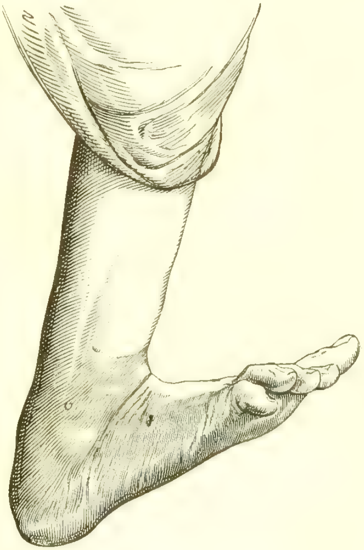


FIG. 86.—Talipes calcaneus.

Analogous deformities are caused by paralysis of other groups. Talipes calcaneus is due to loss of power over the muscles of the calf (fig. 86); valgus is said to occur when the tibials are affected, and compound forms if more than one group is weakened. Very often these are rendered still more complicated by secondary displacements caused by attempts at progression. Thus inversion and rotation may occur to such an extent in talipes equinus that a condition closely similar to true varus is produced, the foot being displaced aterally to compensate for the want of flexion. In other instances valgus follows, but as a rule these additional deformities can be recognised as such by examining the foot when lifted from the ground; as soon as the weight of the body is taken off it drops of itself into the straight line.

Treatment.—This is entirely different from that of congenital talipes, and depends upon the grade of paralysis and the extent to which deformity has taken place already.

In the slighter cases, in which the power over one or more groups of muscles is impaired without being lost, an attempt must be made to improve the nutrition of the part and compensate for what is lost by educating and developing all that is left. Warm clothing, douching twice a day with cold water, salt baths, friction, massage, pinching, galvanism, passive motion, manipulation, suitably-devised gymnastics, everything, in short, is advisable that can in any way improve the circulation through the part, or strengthen the residue of the muscles. If this can be done deformity can be prevented.

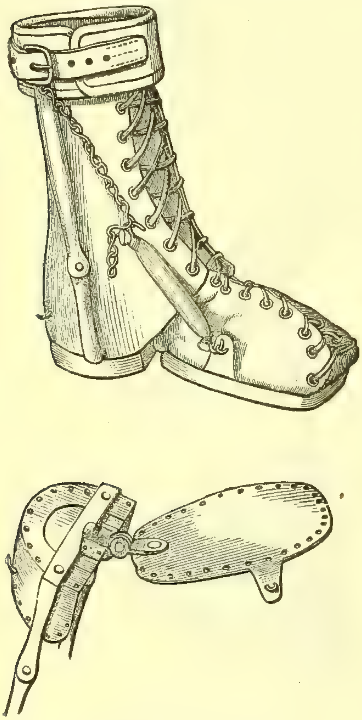


Fig. 87.—Barwell's shoe.

If, however, the whole of one muscle is destroyed its action must be supplanted by a mechanical contrivance. The simplest is a rubber accumulator as suggested by Barwell. A thin piece of sheet lead or poroplastic felt is fastened to the limb, on the anterior surface of the leg, for example, in varus; a soft piece of leather is adjusted round the foot (held in position, if it has a tendency to slip, with some emplastrum plumbi, or emplastrum ferri); a tape is fastened on to this so that it shall descend on the inner side of the foot, pass under the sole, and ascend again on the outer side; and this is connected to the splint with a rubber band of suitable strength. For equinus it is even simpler, as the whole apparatus can be fixed to a boot with side supports maintaining a calf band immediately below the knee. Each case naturally requires a separate plan; but if the defect is a simple one, and permanent shortening has not yet occurred, some contrivance of this kind can often be devised to enable the patient to get about with comfort and maintain the condition of the other muscles and of the rest of the limb unimpaired (fig. 87).

In the worst cases, in which it is not so much one muscle or even one group that is affected, but every one, and in which the circulation is defective, the bones small and light, the skin cold, even in midsummer, and the joints almost like flails, the same plan may be tried, and sometimes, even in the most hopeless cases, an immense amount of improvement is effected by ceaseless, untiring perseverance; but more often it means that the limb is almost useless, except as a support in the narrowest sense of the term, and that some contrivance must be devised to enable it to act as such. The particular variety and the height along the limb to which it must be carried, naturally vary with each case. A boot with outside and inside supports and a calf band may be sufficient in the slighter ones; but in the majority it is necessary to carry the apparatus at least up to the thigh, and not unfrequently up to the pelvis, with joints suitably arranged, and stops so that the limb can be bent underneath while sitting down. The weight, of course, is considerable; the nutrition of the limb, used merely as the central pillar of a mechanical support, does not improve; and as the patient grows older the tendency to the formation of chronic ulcers not unfrequently becomes so marked that amputation is preferred. The flaps, as a rule, heal well, but slowly.

If the patient is not seen until deformity has already appeared, steps must be taken to rectify it by tenotomy and mechanical extending appliances. Thus, in the simplest form of talipes equinus, where the arch of the foot is exaggerated, the tread narrowed, and standing painful, relief may be obtained almost at once by dividing the contracted bands in the plantar fascia. In all cases, however, of paralytic talipes it is advisable to exercise great discretion in the matter of tenotomy, or the already weakened limb may become still worse.

2. *Talipes due to Muscular Rigidity*

What is known as 'spastic rigidity' of the muscles of the lower limb (and occasionally of the whole body) is sometimes present at or shortly after birth, connected, in all probability, either with defective development of the nerve-centres, or with injury sustained during parturition; but the deformities to which it gives rise are rarely limited to the feet; and even when they are, they present but a remote resemblance to ordinary talipes.

Tonic shortening of the gastrocnemius (the so-called right-angled contraction of the tendo Achillis) is not infrequent as a consequence of prolonged confinement with the foot pointing forwards, whether it is due to a badly set fracture or to the pressure of the bedclothes in the course of some exhausting illness, such as typhoid fever. It can be recognised at once by pressing the knee well back while the leg is extended; and though it does not appear serious, it causes a very considerable degree of lameness in walking, and not infrequently ends in grave deformity. The movement that cannot take place at one joint must take place at another; and the arch of the foot gradually gives way until a condition closely resembling ordinary flat-foot is produced; the head of the astragalus and the scaphoid sink together, and in some extreme cases the inner border of the foot becomes convex. Sometimes, on the other hand, especially in those instances in which no attempt at walking is made, the foot is twisted into a shape resembling varus, the natural position it assumes when at rest; but it rarely happens that this is permanent unless there is at the same time paralysis of the extensors.

In every case of fracture the foot should be carefully kept at a right angle throughout; if the toes are allowed to point, serious disablement may be produced before it is noticed; and attention should be paid to this in cases of exhausting illness; the bedclothes should not be allowed constantly to weigh the feet down. If it is present already it can usually be cured by massage, passive motion, and the use of an extending rubber band; but occasionally tenotomy is required.

FLAT-FOOT

The antero-posterior arch of the foot is maintained partly by ligaments, partly by muscles; the former are the inferior and external calcaneo-scaphoid, and the anterior fasciculus of the internal lateral of the ankle-joint; the latter, the tibialis anticus, the flexors of the toes, and especially the peronæus longus, which passes like a strap across it, and prevents the anterior pillar slipping forwards when the weight of the body rests upon it.

Cause.—Neither ligaments nor muscles are capable of maintaining the arch of the foot by themselves; the combination is essential. Some of the worst cases of flat-foot follow Pott's fracture when the internal lateral ligament of the ankle-joint is torn; while, on the other hand, it is often the result of loss of power in some of the muscles; the rest become tired out, and the ligaments which are not calculated to stand a persistent strain, yield and give way under the weight.

Independently of accidents, it may occur in infancy, at puberty, or in adult life. At birth the arch has hardly any existence; it only becomes perfect, like the curves of the spine, when the muscular system becomes active, and if, from rickets or any other cause in early childhood, the time at which this takes place is much delayed, the development of the arch is seriously impaired. It is probable that in this matter rickets is of unusual importance; although the change is not so obvious there can be little doubt that the osseous nuclei in the tarsus are affected in the same way as those elsewhere, and that the shape of the bones, especially when the rickety period is prolonged, may be permanently altered, rendering subsequent development imperfect. It is not uncommon to find every single member of a family flat-footed from early childhood.

The form of flat-foot that occurs at puberty is still more common, and is nearly always associated with genu valgum and lateral curvature of the spine. The causes of the three deformities are the same, and naturally they usually occur together. The strength of the bones and ligaments is dependent upon the perfection of muscular development; at puberty, if growth is rapid, the weight of the body becomes too great for its strength, the muscles give way, the strain falls upon the ligaments, which are already weak and lax, and deformity follows, either in the feet, the knees, or the spine, or in all three together. At first the bones are unaffected, but in a very little while they become altered in shape, and then, short of operation, the condition is permanent. When the food is poor, the hours of labour long, and the patient kept standing without a rest the whole time, deformity is exceedingly rapid.

In adults, flat-foot rarely occurs except as a result of accident (Pott's fracture), of rheumatism (gonorrhœal or not), or of some illness that seriously affects the strength of the muscles, such as diphtheria or typhoid fever. I have known it result from a violent blow on the upper part of the fibula injuring the peronæi, either directly or through their nerve-supply.

Symptoms.—The alteration in shape is characteristic. The astragalus slowly sinks forwards, slipping as it were off the sustentaculum, which sinks with it; the scaphoid is displaced, or even partially dislocated, the axis of the os calcis is no longer directed upwards, the inner side of the foot is lengthened, and when the patient rests his weight upon it the whole of it touches the ground. In the worst cases the outer edge is a little raised and everted, and the peronæi tendons stand out like rigid cords.

In the rheumatic and gonorrhœal forms the pain is intense; in the ordinary one that occurs at puberty, the foot is perfectly easy of a morning; the muscles are rested then and can do their work. By-and-by, however, they become tired, the strain falls upon the ligaments, and the pain as they stretch grows more and more severe. It ceases at once if the foot is raised from the ground. Sometimes in these cases, when the strain is kept up continuously, there is a considerable degree of inflammation, and the astragalus and scaphoid may even become ankylosed. More often the arch sinks completely down, and then the pain subsides; the weight is borne by the bones directly, and there is no more stretching.

In many instances the foot is perfectly flat, even when there is no weight resting upon it; in doubtful cases it is advisable to let the patient stand for a moment with his feet just wetted upon a sheet of coloured blotting-paper; the surface that comes into contact with the ground when his weight bears upon the arch can be seen at a glance.

Treatment.—In the early stages of the deformity, while the arch still persists, much may be done by means of massage, cold sponging and tiptoe exercises. The nutrition of the muscles improves, and if long standing and fatigue are avoided, the cure is often permanent. The heel of the boot should in all cases be deeper upon the inner side than the outer, as recommended by Thomas, of Liverpool.

If the arch is already lowered, and the patient's occupation cannot be changed, cure is practically hopeless; the cause continues and the effect will grow worse. Relief, however, may be obtained by wearing properly contrived supports. In the slighter cases, a valgus pad made of rubber, or, if this is too hard, of leather stuffed with horsehair, may be fixed inside the boot. The heel should be broad and low, the waist fairly rigid, and ample space allowed in front. The pressure must, it is true, act to a certain extent injuriously upon the tissues in the concavity, but it is a choice between two evils.

In worse cases, when the foot remains flat, even though no weight is resting upon it, this is not enough; however well made the boot, the foot is sure to rotate in it, and the only way to make it secure is by means of an outside iron. The lower end of this is let into the heel; opposite the ankle it is jointed, and above it is fastened by a band round the calf. A triangular piece of leather is sewn inside the boot, on its outer border, so that it passes under the sole of the foot, beneath the astragalo-scaphoid articulation, up the inner side, through a slit in the uppers, and is buckled to the iron. Or a rubber band is used in the same way, after Walsham's plan (fig. 88). For a time at least this gives relief; and if tiptoe exercise is diligently practised, after some months there may be distinct improvement.

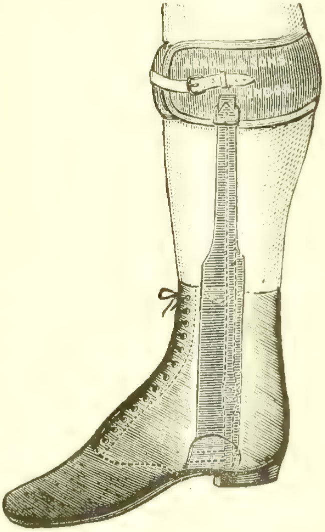


FIG. 88.—Walsham's shoe.

When the pain is very great, and the peronæi tendons are tense, this cannot be carried out at first. The foot must be rested and raised, until the tenderness has subsided; then the patient is placed under an anæsthetic, all the joints worked and wrenched to their full extent, and the foot brought into the best possible position by forced inversion, combined with direct pressure upon the scaphoid. This position is maintained for a week or ten days by means of a plaster bandage, and then the process is repeated until something like an arch is restored. The peronæi tendons should not be divided if it can possibly be avoided.

In some of those that are worse still tarsectomy and other similar operations are recommended. The head of the astragalus has been excised (Stokes) and the foot forcibly adducted. The astragalo-scaphoid articulation has been opened freely, sufficient bone removed to enable the arch to be restored, and the two bones drilled and fixed with a couple of ivory pegs passed through them (Ogston); and the scaphoid has been excised by others. It is possible that in some cases in which there is persistent pain these operations may be of some use; they undoubtedly restore the shape of the arch, although it is probable that bony ankylosis always occurs (in Ogston's this is partly the object); but seeing that they can only be recommended for extreme cases, and that these have for the most part already passed the painful stage, the number for which they are advisable is very small. When the arch has once become flat, so that the inner border of the foot rests upon the ground, the gait is very ungainly it is true, but the inconvenience rarely is sufficient to recommend an operation which practically must lay the patient up for many months.

Deformities of the Toes

Hammer-Toe

This name has been given to a peculiar deformity which affects the second toe in particular, but sometimes all. The first phalanx is retracted at the metatarso-phalangeal articulation, the second is flexed at right angles to the first, and the third bent so that its true extremity is directed downwards. In the earlier stages of the disease the parts can be placed in the normal position without difficulty, but after a little while the ligaments contract and the displacement is permanent, the first phalangeal joint becoming rigid, as a rule, before the metatarso-phalangeal one.

The cause of this deformity is unknown in most cases. It is not unfrequently congenital and even hereditary; usually it is symmetrical and often confined to the second toe. It may be associated with the slighter forms of talipes equinus (talipes arcuatus and plantaris) and caused by contraction of the plantar fascia; or the rest of the foot may be absolutely normal. That it can be produced by wasting of the interossei there is no doubt, as it is not unfrequently seen in cases of progressive muscular atrophy: these muscles flex the metatarso-phalangeal articulation and extend the other two, and when they alone are paralysed the various segments naturally assume the opposite position. In the vast majority of instances, however, no evidence of paralysis is present. The lower part of the lateral ligaments of the first phalangeal joint is always much shortened and contracted, and it has been suggested that the deformity is due to chronic inflammation beginning in this articulation; but it is equally possible that the change is a secondary one, caused by permanent fixation in an unnatural position. The changes in the other structures of the joint, no doubt, are secondary. Whether it can be caused by ill-fitting boots is equally uncertain; it is probable they aggravate the deformity, but as it is occasionally present at birth (though it more frequently develops at puberty), and as it is not more common in one class of life than another, hospital patients suffering as frequently as those in a better station, the influence they possess is doubtful.

Treatment.—In the slighter cases, in which contraction has not yet taken place, relief may be obtained by wearing suitable boots, sufficiently broad in front, with low heels, and by massage and friction. If this does not succeed an attempt may be made to keep the toes extended by means of a metal sole-plate, worn at night, and as long during the day as practicable. The portion that comes under the toes is provided with slits through which little elastic and leather bands are passed, so as to draw the toes down; or the plate may be double, one part above the foot and the other below, with little screws and pads so that direct pressure can be exerted upon the joints from above.

In most cases, however, the time for such simple remedies as this is already past. The contraction of the ligaments and fascia is too rigid to admit of gradual extension, and the toes are distorted and deformed with callosities. The choice then lies between division of the lateral ligaments, excision of the proximal end of the offending phalanx, and amputation. Of these the second is the only one that holds out a definite prospect of relief without risk of relapse and without the mutilation involved in amputation. Subcutaneous section of the lateral ligaments, however, is such a simple proceeding and lays the patient up for such a short time that it may easonably be tried first.

Deformities of the Great Toe

(*a*) *Hallux flexus.*—This deformity, described by Davies-Colley, closely esembles hammer-toe in many respects. It occurs under the same con-itions; it is apparently not, like hallux rigidus, dependent upon flat-foot, nd it usually develops at puberty; but the metatarsophalangeal joint is exed instead of being over-extended, and the toe is wholly bent downwards, o that the patient is compelled to walk upon the outer side of the foot. The uggestion that the difference is to be accounted for by the different development of the great toe, the metatarsophalangeal joint corresponding to the nterphalangeal of the others, is attractive, but probably not correct, as true ammer-toe is sometimes met with.

(*b*) *Hallux rigidus.*—This name has been given to a peculiar stiff and ainful condition of the metatarsophalangeal articulation. Considerable oubt exists as to whether it is not identical with the former (although the e is kept in a straight line with the foot); it differs, however, in being early always associated with flat-foot, and probably dependent upon it, flammation of the joint being caused by repeated slight injury from illting boots. A similar condition is sometimes produced by osteoarthritis.

It is usually met with at puberty and in boys who have to stand for many ours together. In the early stages there is often a certain amount of flammation, but it is rarely very marked or prolonged. Nearly always the e is cold, stiff, and rigidly extended, sometimes quite straight, sometimes th a certain degree of valgus. The least attempt at flexion causes severe in, and in all but the slightest cases there is distinct enlargement with ping and hypertrophy of the articular ends. The nature of the deformity can often be detected at once by noticing the condition of the boot: the arch is flat; there is a projection in front where the toe presses against it, and there are no wrinkles in the leather, showing that the joint is never used.

The treatment of this affection, like that of hallux flexus and hallux valgus is very unsatisfactory. If seen in time it may be cured by restoration of the arch of the foot, but nearly always extensive changes have made their appearance in the articular surfaces before the patient is aware of the extent of the mischief. The question then turns upon the amount of pain; if it is only slight a well-made roomy boot with a valgus-pad may answer; but if it is more severe, particularly if it prevents the patient taking a fair amount of exercise, the best plan of treatment is to remove a sufficient portion from the proximal end of the first phalanx. The same thing must be done for hallux flexus.

(c) *Hallux valgus.*—The deformity affects the same joint, but the toe is bent outwards, either over or under the others, until it may be at right angles to its normal direction. This, there is no doubt, is always due to ill-fitting boots. The articular changes in the early stages are the same as in hallux rigidus, and in other forms of chronic traumatic arthritis; but after a time gouty or rheumatic inflammation usually follows, and urate of soda is deposited, or immense lips of bone are formed and the surface becomes hard and polished from friction.

Hallux valgus derives much of its importance from its association with bunion, a bursa developed over the inner side of the joint from the constant pressure and friction of the boot. This may be found in all stages of inflammation; when it is recent there is merely a thin-walled sac, filled with clear fluid; after repeated attacks it becomes thick and fibrous until, with the corn that lies upon it, it forms an almost solid swelling; or else it suppurates, and then it becomes serious, from the fact tha it nearly always communicate with the joint. In most cases however, by this time the cartilage have disappeared and there i nothing left but two hard, bon surfaces held together by a toug fibrous capsule.

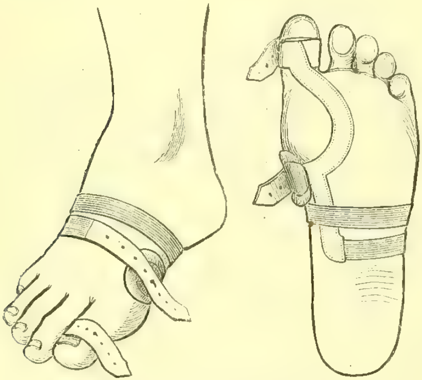


FIG. 89.—Lever for relief of hallux valgus.

The treatment in the earlie stages is very simple; the boot must be made the shape of the foot—straight that is to say, upon the inner side; and at night, and whenever it is convenient, a sole-plate must be worn with a spring upon its inner border t draw the toe into line again. If matters have gone too far for this, all tha can be done is to prevent further injury. Should suppuration occur i connection with the joint, a free opening must be made upon the inner sid and a sufficient portion of the base of the first phalanx removed to bring th toe into the right line again. The metatarsal itself is better left untouche but a fair amount of bone must be taken away or osseous ankylosis will ensu Osteotomy of the neck of the first metatarsal is recommended for simpl hallux valgus, bringing the toe into line at once, and as it can be don almost subcutaneously is not a serious operation, but it rarely happens that patients consider the deformity alone a sufficient reason, as it seldom causes much discomfort until a bunion is developed.

Genu Valgum

Knock-knee, like the other deformities due to want of strength, may occur either in childhood or at puberty. In the former case it is always associated with rickets ; in the latter it is usually met with in conjunction with flat-foot and lateral curvature of the spine. Owing to the width of the pelvis the natural direction of the femur is from above obliquely downwards and nwards, and this determines the direction of the deformity : the disproporion between the weight to be carried and the strength of the muscles (upon which the perfection of the ligaments and bones depends) regulates the amount; and when once it has commenced it naturally advances at a much more rapid rate.

The nature of the deformity is obvious at once, but the extent requires areful measurement. The lower margin of the internal condyle is prolonged downwards far below the level of the external ; but it does not project in he least backwards. Consequently the legs are perfectly parallel when the nees are bent, and diverge only when they are extended. The essential hange is an overgrowth of the inner border of the diaphysis, although the nternal condyle may be itself somewhat elongated.

That it is solely due to obliquity of pressure and consecutive alteration n the shape of the bone is shown by the similar distortion that occurs when he thigh has been amputated in a child, and no artificial limb has been orn. From constantly bringing the remaining leg under the centre of ravity of the body, so that the crutches may be swung forwards, it assumes condition of extreme genu valgum, the inner condyle being prolonged ownwards and not backwards in precisely the same manner. The two orst cases I have ever seen were caused by this ; the method of production identical with that of the ordinary form which develops at puberty ; the ause is somewhat different.

Treatment.—This depends upon the degree of deformity and the length time it has lasted. In any case a certain amount of rest is the first condeeration ; the cause, as in lateral curvature, is excessive work ; the strength not equal to the weight, and so long as the weight is allowed to press upon e knees and drive them inwards the deformity must grow worse.

(*a*) In children in whom there is other evidence of rickets the prognosis good unless the hardening stage has set in, and buttresses of compact ssue have been deposited in the concavities of all the bones ; if this has curred the condition is permanent, short of operation. Cod-liver oil, iron, od food, meat, eggs, and milk are essential. In the slighter cases it is possible to confine the child to bed, but it should never be allowed to tire elf; the nutrition of the legs and of the muscles in particular must be intained by rubbing with oil night and morning, bathing with salt water, ction, massage, warmth and galvanism. If this is thoroughly carried out e limbs gradually become straight of themselves.

If the condition is more serious—if, that is to say, there is a definite erval of some inches between the malleoli when the knees are extended— same plan must be pursued ; the child must be kept in bed and splints applied every day, to draw the knees slightly outwards. Too much pressure should not be used; the skin is exceedingly delicate and sores are easily formed; but, on the other hand, unless the parts are well fixed, children can always twist their legs round until by slightly flexing the knees they escape pressure altogether. Where trouble is no object the splints should be removed night and morning, an inside one being worn at night, an outside one in the daytime; and every time they are changed the skin should be thoroughly rubbed, the muscles kneaded and the part manipulated into the right direction with as much force as is consistent with avoiding pain.

An extraordinary degree of improvement can be effected in this way in a very short space of time. The muscles gain size and strength; the tone of the limb improves; the legs grow straighter and the inequality between the condyles disappears. I have more than once seen a leg become perfectly straight while a child was lying in bed recovering from an osteotomy performed upon the other one. It is, however, of little or no good after sclerosis has set in.

(*b*) The form of knock-knee that developes at puberty must be treated on the same principles. It is nearly always met with in those whose occupations compel them, just at the time they are growing most, to stand many hours a day; and it is nearly always associated with flat feet. Of course if the occupation is continued very little can be done; the deformity will grow worse until a kind of equilibrium is reached; but if this can be changed, and the tendency to flat-foot checked either by a valgus-pad or by Thomas's obliquely-cut heel, the limbs can generally be brought into the right line again.

In worse cases, in which the period of growth is ended, or in which the deformity when the knees are extended is considerable, osteotomy affords the best prospect. At this age it is not possible to effect any considerable change in the shape of the bones, as it is in children and especially in rickety children. If pressure is persisted in, the fibrous structures on the outer side of the joint, the external lateral ligaments and the iliotibial band are very likely to yield, and allow the external condyle to separate itself from the tibia, so that when the splints are removed and the patient is allowed to stand upright, he is merely propped up in a most insecure manner upon the internal condyle.

Rickets

In rickets many deformities of bones are met with besides genu valgum. The femur is often bowed outwards and forwards: the tibia is bent, especially at its lower extremity where it is weakest, until the convexity of the curve seems to hang over the ankle; and in other cases again the femur and tibia together are curved outwards, so that exactly the opposite condition to genu valgum is produced—bow-leg, or genu extrorsum. The particular kind of deformity is regulated partly by the natural curve of the bones, partly by the attitude and habits of the child, whether it is old enough to run about, or sits tailor-wise upon the ground. In some rare instances genu valgum on one side is associated with the opposite deflection upon the other, but this is more usually a product of later life, caused by accidental deformity.

The treatment is the same as that for genu valgum. If the bones are still soft and the weight is taken off them, and if the strength of the child and the condition of its muscles can be sufficiently improved, the deformity disappears of itself. Splints are of no use in the majority of cases; the anteroposterior curvature of the tibia, for example, does not admit of pressure being applied; and it is questionable whether the fashion of fastening them on so that they project below the feet and prevent walking does not do more harm than good: for not unfrequently the child learns to shuffle about with its limbs in a worse position than they were before.

If the rickety stage is passed, and deformity is left, it can only be rectified by osteotomy.

Osteotomy.—Section of a bone for reduction of deformity, or osteotomy, is performed either with a chisel or a saw. The former, as a rule, is preferable, not so much because of the dust caused by the teeth, as because of the almost unavoidable laceration of the soft parts; and MacEwen's, made of solid metal throughout and graduated, are the best. If a saw is used, no instrument has superseded that devised by Adams for subcutaneous section of the neck of the femur.

The operation is subcutaneous so far as it is possible to make it. The limb is thoroughly cleansed and embedded firmly on a sand-bag covered over with a rubber sheet. A small incision, parallel to the most important structures, is made down to the bone at the spot at which it is intended to divide it, and the chisel or saw passed down by the side of it before it is withdrawn. If a chisel is used, care must be taken always to work away from important structures; with a little practice, the different sensation as it passes from compact to cancellous bone or *vice versâ* can be appreciated at once; but there is no object in running any risk. MacEwen recommends that the surgeon should always cut towards instead of from himself, and that, if the structure to be divided is very wide, and the chisel deeply buried, a narrower one should be substituted for it as soon as the first incision is made; it is impossible to form a correct impression if the instrument is fixed, like a wedge, by the sides of the cut. The chisel must be held in a firm grasp, and should be loosened in its bed from time to time as required by an upward and downward movement, not a transverse one, for fear of splintering.

The general rule is to divide the compact tissue opposite the point of entrance of the chisel first; then (if it is working from the side) that on the upper and under surface of the bone; and finally the soft central portion, leaving in this way the part on the farthest side uncut. If the bone is very wide the last part may be effected with a narrower chisel, which will produce something of the effect of a wedge-shaped wound. As soon as the division is considered sufficiently complete, the chisel is withdrawn from the bone with an upward and downward movement, gradually loosening it; a sponge placed over the wound and the remaining part of the compact shell fractured. Some iodoform is then dusted over the surface; a catgut suture inserted if necessary; then an absorbent dressing, and a suitable splint, taking care to move the limb as little as possible while it is being applied.

Operations for Genu Valgum.—Many operations have been devised for the correction of this deformity; but except in special cases, MacEwen's is the one that is always practised. It consists in subcutaneous section of the lower end of the femur, immediately above the condyles, with a special chisel.

The cutaneous incision commences at the junction of a line drawn transversely a finger's breadth above the external condyle with a longitudinal one half-an-inch in front of the tendon of the adductor magnus. The scalpel is carried down to the bone and the incision prolonged sufficiently to admit the osteotome. This (beginning with the largest) is introduced by the side of the scalpel before it is withdrawn, and then turned round through a right angle. The posterior internal border is the part first divided, the chisel pointing forwards and outwards; then the internal border; and after that towards the outer posterior angle, working always from the artery. After the compact layer is cut through it is advisable to change the osteotome for one with a narrower blade, especially in the case of an adult. Then the residue of the bone is fractured, the limb brought into a straight line and a suitable splint applied. In children, the most convenient apparatus is one of the ornamental flower-pot holders made of diagonal bars; it can be placed in position at once; and it is sufficiently flexible to fit accurately over the dressing. If the little wound is sealed with iodoform and covered up with wood-wool, there is no need to disturb it until the fracture is sound.

In Ogston's operation the internal condyle of the femur is detached and pushed farther up the shaft. It may be performed either with a chisel or a saw. A long-bladed tenotomy knife is introduced two or three inches above the internal condyle and pushed through the tissues until it can be felt in the inter-condyloid space; the soft structures are then divided down to the bone; Adams' saw passed by its side, and the tenotome withdrawn. The internal condyle is sawn about three-quarters through from above downwards, and the fracture completed by forcibly straightening the limb. The same precautions and the same after-treatment are required as before.

Reeves, who uses round-edged chisels without angles, modifies this by only dividing the bone and leaving the cartilage to be ruptured.

Redressement (forcible straightening) was practised largely at one time, but though the limb can often be brought into a straight line, it is impossible to say what yields, it may be the epiphysial line, or the lower end of the shaft, or the ligaments.

Whatever form of operation is used the limb requires support for many months. It must not be forgotten that, though the deformity is cured, the causes that gave rise to it are probably there still, and that, unless precautions are taken, it will infallibly return.

Rickety deformities of bones are treated on the same principles. Subcutaneous fracture (either manual or with an osteoclast) succeeds sometimes, the bone breaking (or if it is still soft, bending) at the weakest spot, and enabling the limb to be brought straight at once. In most cases, however, osteotomy is preferred, either simple linear division, or, if the deformity is very great, cuneiform—that is to say, the excision of a wedge.

SECTION II.—INJURIES OF BONES

FRACTURES

A fracture is a sudden interruption in the continuity of a bone, produced by violence. For convenience of description this definition is allowed to include other injuries similar in character, such as separation of the costal cartilages from the ribs, and in young subjects separation of epiphyses.

Fractures are divided into two classes, *simple* and *compound.* In the former the skin is unbroken, the fragments are never exposed to the air, there is no risk of absorption, and the injury is repaired like a wound that heals by the first intention; in the latter, the broken ends are laid bare at some time or other, a way is opened up for the absorption of foreign substances, and there is (so long as the wound is open) the constant danger of cellulitis, necrosis, phlebitis, pyæmia, and other troubles.

A fracture may be compound at the time of the accident, or may become so at a later period from sloughing of the skin and soft tissues over the broken ends. When it is compound from the first, either the wound and the fracture are produced together by the same force—a cart-wheel, for example, passing over a limb and tearing the skin from off the bone as it crushes it; or the pointed end of one of the fragments is driven from underneath through the skin, owing to involuntary muscular contraction at the time of the accident, or want of care in handling the part afterwards. In the former case (*compound by direct violence*) the injury to the soft parts is generally extensive: they are bruised and crushed for a considerable distance on either side; in the latter (*compound by indirect violence*) there is only a puncture, the wound may close at once and the fracture become, to all intents and purposes, a simple one.

The danger is less when the fracture becomes compound secondarily from sloughing or other causes. Absorption from the surface is not so easy; the gaping channels that are present in a recent wound are sealed by the lymph already thrown out, and the current sets rather from the deeper parts outwards, so that, provided the sloughing is local and limited, the risk of septic poisoning is not so immediate.

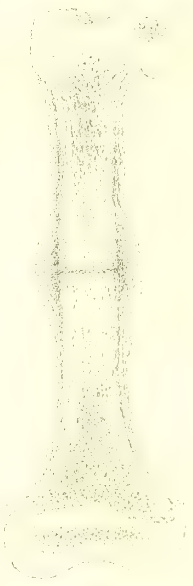


FIG. 90. — Transverse sub-periosteal fracture of femur with beginning of callus. From an infant.

Fractures, simple or compound, are said to be *complicated* when the viscera or other important structures near are involved; when, for instance, the ribs are driven into the lungs or liver, or when a large artery is punctured or torn across.

Fractures are *complete* if the bone is broken right across; *incomplete* if the injury falls short of this in any way; and *sub-periosteal* if, as often happens in children, the tough periosteum remains untorn (fig. 90).

The cancellous tissue of a bone, for example, may be crushed and compressed, or a splinter may be chipped off from the side; or the compact tissue may be fissured in one or more directions without any fragment being actually detached. A peculiar form is common in children, affecting the long bones, especially the clavicle. The osseous tissue in them is so soft and elastic that it can bend, in some cases almost to a right angle, without breaking, and regain its shape completely as soon as the pressure is removed. Generally, however, before this point is reached, longitudinal fissures make their appearance in the bones, and then, if the force continues, the periosteum and the compact tissue at the apex of the curve begin to tear, until the fracture extends perhaps half across. These are called *greenstick* fractures, as the bone is not actually broken in two; they do not regain their shape when the force is spent, and often, owing to the jagged nature of the end and the way they fit against each other, there is considerable difficulty in straightening them again (fig. 91).

A fracture is *single* when the bone is broken in only one place, *multiple* when it gives way in more than one, and *comminuted* when there is a number of small fragments at one spot. It may vary in direction as well as in extent and be *transverse*, *oblique*, or *longitudinal*. Sometimes, as in the patella, it is *stellate*; sometimes *serrated* like the teeth of a saw; or it may run round a long bone in the form of a spiral. It is T-*shaped* when there is a transverse fracture immediately above a joint and the smaller of the fragments is split vertically into two (fig. 93); *punctured* when there is a wound in the substance of the bones; and *perforated* when it goes right through. Finally, if one fragment is driven into the substance of the other—if, for example, the compact wall of the shaft is driven into the soft cancellous tissue of one of the articular ends, so that the two are locked together, it is said to be *impacted*.

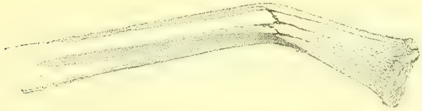


FIG. 91.—Greenstick fracture of radius showing the longitudinal splintering. In this case it ran down to the epiphysis, which has been separated by maceration.

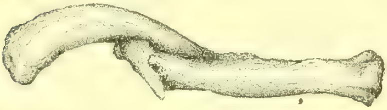


FIG. 92.—Comminuted fracture of clavicle.

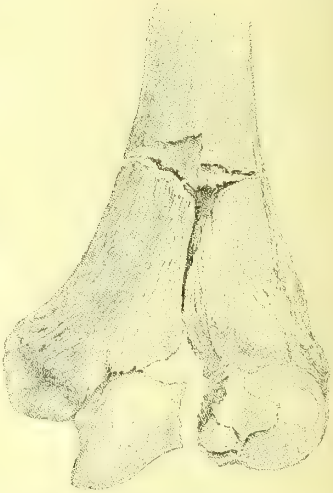


FIG. 93.—T-shaped fracture of lower end of humerus.

Influence of age.—Fractures are met with in all periods of life, but with very different degrees of frequency at different ages.

Intra-uterine fractures are not uncommon. They may be caused by muscular contraction of the walls; but in most cases they can be traced directly to a severe fall or a violent blow upon the abdomen during pregnancy.

The long bones, especially those of the leg, suffer most frequently, the skull from its protected position and its elasticity generally escaping; sometimes they are compound and a scar is found upon the skin corresponding to the point at which it was perforated by the bone. The degree of union depends upon the time; as a rule it is fairly firm, though the position may be faulty. Multiple fractures (and in some instances an enormous number has been recorded) rarely occur except in the case of intra-uterine disease, possibly hereditary syphilis.

It is noteworthy that in quite half the cases in which the leg is found at birth to be bent at an angle as if it had been broken, and even when there is the appearance of a cicatrix at the point, the fibula and the toes on the outer side of the foot are deficient. Talipes is often present at the same time; the limb is imperfectly grown, and frequently remains more or less stunted throughout life.

In infancy, the clavicle and the femur are the bones that suffer most frequently, and the fractures are often greenstick or sub-periosteal. Separation of the epiphyses is common in childhood, but may be met with up to one or two and twenty years of age. In adult life, much depends upon the sex and occupation. The bones are harder and more dense than they are at earlier periods. Fissured fractures occur more easily, and, as a consequence, the joints are more often involved. Old age is specially characterised by two varieties, fracture of the neck of the femur and (particularly in women) fracture of the lower end of the radius from falls upon the hand.

CAUSES

The causes of fractures are predisposing and immediate. The former include all those conditions which render the bone more fragile; the latter, the actual breaking force. If this is unusually slight, so that the bone gives way without (apparently) sufficient reason, the fracture is said to be spontaneous.

1. *Predisposing causes*

These may involve the whole length of a bone (and even the whole skeleton) or may be local, affecting the structure and impairing the strength at one part only.

(*a*) *General.—Simple atrophy* is the most common. When a limb is kept at rest for any length of time—rigidly confined in splints, for example, owing to disease of some neighbouring joint—the bones gradually waste away, the cancellous tissue becomes more and more open, the medullary canal enlarges, and the compact layer is absorbed from the interior, until, in extreme cases, a thin shell of solid substance is all that is left. It is in certain measure owing to this, that if a bone once broken gives way a second time before repair is complete, it nearly always yields—not at, but close to, the seat of the original injury. Atrophy is also said sometimes to follow injury to the nutrient artery.

In old age the bones are affected in a similar way, and in addition the proportion of lime-salts to the organic basis appears to increase, so that they become more brittle. This cannot, however, be called pathological unless the change reaches an extreme degree, so that an unusually slight amount of violence is sufficient to make them give way.

Infantile paralysis, owing to the feeble nutrition of the limb, leads to the same result. The bones never attain their full development; they remain slender and feeble; the surface is smooth, without any muscular ridges to act as supports, and they are deficient in weight and strength.

Fractures are very prone to occur in certain *affections of the nervous system.* The nutrition of the bone suffers whether the limbs are kept at rest or not; there is no tendency to inflammation, but two-thirds of the inorganic material (especially the phosphate of lime) may disappear; the cortex becomes exceedingly thin, and the medulla replaced by fat, until in some cases the bony substance is so soft that it can be cut with a knife. This has been noticed particularly in locomotor ataxy, affecting chiefly the lower limbs, and appearing even before the inco-ordination; in general paralysis, where the ribs seem to suffer most, and also in some cases of dilatation of the central canal of the spinal cord. It is singular that if the bones do give way under these conditions, union often takes place easily and with an exceptionally large amount of callus.

Rickets is another common cause. The intermediate layer of cartilage becomes abnormally thick; instead of there being merely a line of soft tissue ready to be replaced by bone, it may form a broad band of gelatinous material, in some cases nearly as thick as the cartilage of the epiphysis itself. The deeper layer of the periosteum is affected in the same way; and, as the process of absorption from the interior continues with unabated vigour, the strength of the bone at last becomes impaired to such an extent that it is unable to bear any strain. Owing to the thinness of the compact tissue in comparison with the thick layer of soft material on the outside, subperiosteal and partial or green-stick fractures are very common, especially at those places where the bones are naturally curved. So long as the rickets is actively progressing, the amount of callus is only small; afterwards, it is thrown out in great excess, particularly on the concave side.

In *osteomalacia* the bones, if they are exposed to any force, do not break so much as double upon themselves and bend. The compact tissue is softened and disappears; the Haversian spaces and the medullary canal grow larger and larger, until at length in the more severe forms, all that is left is a cylinder of osseous tissue, as thin as paper, filled with a kind of reddish-brown pulp, and unable to resist a strain of any kind.

In certain people the bones are peculiarly liable to break, without its being possible to assign a reason for it. Their health is to all appearance perfectly good, and the fractures unite without difficulty. This condition, which sometimes affects several members in one family, and which may be hereditary, for want of a better name is known as *Fragilitas ossium.*

(*b*) *Local.*—These are for the most part connected either with inflammation, or with the presence of some new-growth of or in the neighbourhood of the bone.

Inflammation, if the process of repair does not keep pace with that of destruction, of necessity renders the bone more likely to give way. In acute suppurative osteomyelitis, for example, total necrosis and separation of a portion of the shaft may take place before a sheath of new bone can form; or, after this has been thrown out by the periosteum, it may be so weak as to bend or break almost of itself as soon as the sequestrum is removed. The same accident sometimes complicates inflammation and suppuration in the medullary canal, even when there is no sequestrum of appreciable size; and it has been known to occur from rarifying ostitis gradually eating away the interior of the shaft without any corresponding deposit being formed on the exterior. Caries involves the shafts of bones so rarely that in this respect it is of little importance, except in the case of the ribs and the odontoid process.

Separation of an epiphysis, due to softening of the cartilage, is sometimes discovered unexpectedly in the course of acute periostitis and osteomyelitis. It is most often met with at the upper end of the tibia, and union may have taken place in a faulty position before it is noticed.

The most common local cause is the presence of some *new growth* such as sarcoma or carcinoma. Sometimes the fracture is preceded by swelling or by constant pain, but it is not unusual for there to be no suspicion of anything wrong until one of the bones unaccountably gives way.

Central sarcomata are the most important. They grow from the interior, very often at the epiphysial ends, and replace the bone until there is nothing left but a soft vascular mass which may retain the shape of the part, or cause it to expand into a thin-walled cyst. Periosteal ones, as a rule, do not interfere to a sufficient extent with the structure of the bone. Secondary deposits of carcinoma, especially after scirrhus of the breast, may lead to the same result. Apart from the local growth there is no evidence that either the cancerous or the sarcomatous cachexia has any special influence on the stability of the skeleton.

Enchondromata, cysts, and echinococci occasionally weaken the bone in which they grow, so that it gives way unexpectedly ; and sometimes the same result follows from absorption due to the pressure of external tumours, such as an aneurysm.

Syphilis occasionally acts as a predisposing cause by the local changes it induces—caries, or much more often gummatous infiltration of the periosteum or bone. *Scurvy* hardly seems to have any influence, except perhaps in the case of the costal cartilages. It is stated that when it is very severe these are liable to be detached, owing to changes which take place at the ends of the ribs, and which are often associated with hæmorrhagic periostitis.

Changes of a similar character occur at the ends of the long bones (particularly the lower epiphysis of the humerus) in young infants as a result of hereditary syphilis, and more rarely scurvy, so that the growing ends are liable to be separated by very slight degrees of violence. Some of these may be genuine examples of detached epiphyses ; in others it is probable the line of separation runs through the softened and infiltrated layer of bone bordering the end of the shaft.

2. *Immediate causes*

These are either external violence, or muscular contraction, or in some instances a combination of the two.

(*a*) *External violence.*—This may be *direct* or *indirect*. In fractures by direct violence the bone is broken at the seat of the injury, as when a limb is run over and crushed by a heavy wheel ; the fracture is often comminuted and the soft parts seriously injured from the way in which they are ground between the offending object and the bone. In the other variety the fracture occurs at some other, perhaps far-distant point, where the strength of the bone or chain of bones is least, and the soft tissues may escape almost entirely. In falls, for example, upon the outstretched hand, the shock is transmitted through the arm to the clavicle, and this gives way at its weakest point. The two ends are driven together and the bone is bent more and more until the limit is reached.

Fractures at the base of the skull and fractures by what is known as *contrecoup* (where the bone is broken exactly opposite the point on which the violence falls) are caused in the same way. The skull, which is exceedingly elastic, is compressed in one of its diameters, the vertical if the force falls on the vault, and proportionately lengthened in the others; and the bone breaks where it is weakest and most brittle, generally at the base. In other instances, however, as in falls upon the feet, the fracture occurs from the impact of the base of the skull upon the vertebral column, as when the head of a hammer is driven home upon the handle by smartly striking the latter on the ground.

(*b*) *Muscular contraction.*—If it were not for the patella, which very frequently gives way from this cause alone, fractures due solely to muscular contraction would be regarded as uncommon. Sometimes, however, bony prominences, such as the acromion, or the tubercle of the tibia, are torn off by violent muscular action, and occasionally the long bones themselves snap quite suddenly. Many instances are recorded in which this has happened to the humerus, clavicle, and femur, but in the case of other bones it is exceedingly rare. In most the fracture seems to have been due to the sudden arrest of rapid action, as in striking out at an object without hitting it, and therefore to have been caused in part at least by the weight and momentum of the arm.

REPAIR

Fractures are repaired, like other injuries, by the effusion and organisation of lymph. It is not clear how far this is derived from the blood-vessels, and how far it is the product of the tissues around. It is certain that the medulla and the deeper layers of the periosteum possess the power of causing the development of new bone when transplanted into other parts; but, according to McEwen, the superficial ones are quite inert.

1. *Union in simple fractures*

Early changes.—There is nothing peculiar about these: the injured parts swell up at once, owing to the extravasation, which is always extensive; the blood pours out from the torn vessels, and spreads in the central cavity, and in the loose cellular tissue around, until it is checked by the tension it creates. After a time it coagulates, and the ends of the vessels become sealed; the fibrin and corpuscles form a loose dark-coloured mass, which fills up all the interstices; the serum is carried away by the lymphatics (the neighbouring glands are often swollen at this stage), or, if it is excessive in amount, escapes through the skin and raises up the epidermis in great blebs.

While this is going on, the vessels around the injured area begin to dilate, those in the soft parts first, in the compact bone last, and lymph pours out through their walls; the skin, if the fracture is near the surface, grows warm and red; the blood circulates more rapidly; all the tissues around become softer and more open; the fat is absorbed, and the medulla resumes its embryonic character.

Almost from the first day the coagulated blood begins to lose its colour. The red corpuscles break down; the hæmoglobin soaks into and stains all the tissues near, and the stroma and fibrin disappear little by little before the advancing lymph. Probably the white corpuscles share the same fate, though, as in other cases of extravasation, some few on the outside may remain. Meanwhile, the lymph grows in from all sides, spreading farther and farther, until it finds its way between the fragments into the medullary canal, and joins with that which is developed there.

At this stage, up to the seventh or tenth day, the bone itself is almost unchanged; only the surface near the seat of injury is slightly more porous; the periosteum is swollen and thickened, its fibres are softened, and separated from each other by masses of lymph, so that its deeper layers are almost gelatinous; and it strips off more readily from the bone beneath. Between the fragments, and lying in the central space, is the débris of the old extravasation; and round the whole is an ill-defined soft mass of vascular granulation-tissue, mixed with old blood-clot, and inseparably fused with the torn shreds of the muscles and other structures near.

The amount of lymph thrown out is regulated mainly by the extent and duration of the injury. In children it is true, owing to the activity with which all tissue-changes are carried on, the quantity is relatively greater than at other periods of life; but it rarely happens, even in old age, that it is insufficient for the purpose. On the other hand, the wider the extent of the injury, the more the soft parts around the broken ends are crushed and bruised, so long as they are not actually destroyed, and the oftener the injury is repeated, the greater the amount produced. Where a bone is simply broken, with no displacement or extensive laceration of the periosteum, and where the parts are kept at perfect rest (as for example in fissures of the cranium) the lymph merely unites the broken surfaces, fills up some of the medullary space, and causes a little thickening of the periosteum. On the other hand, in children; in animals; where there is a thick layer of soft tissue on the bone (and if it is on one side, as in the case of the tibia, on that side only); where the fragments are allowed to move one on the other, as in the ribs; and where there is a number of splinters wounding all the parts around, a huge mass may be formed, welding everything together, and filling up the medullary canal so completely that it is divided into two.

Callus.—This effused lymph becomes ossified, and is known as callus. At first it is soft and porous, very irregular in shape, and perforated in every direction by a number of vessels running from all sides towards the centre; later, it shrinks and becomes more dense, the outer layers remain fibrous, and fuse with the periosteum at either end; the rest is slowly absorbed, until there is only sufficient left to restore the strength of the fractured bone. That part of it which surrounds the broken ends and fills up the medullary canal is called *provisional*; it is formed earlier, and acts as a kind of splint; that which directly unites the broken ends is *definitive* (Dupuytren); it is not developed until the other has already assumed the form of spongy bone, and after this has disappeared it forms the permanent bond of union.

The former comes from the periosteum and surrounding tissues, and perhaps to some extent from the medulla, the latter from the bone itself; but there is no real distinction between them. The difference in the time of their appearance is due to the relative ease with which the changes after injury take place in soft cellular tissue, and dense unyielding bone; and the difference in the direction of their vessels depends solely on the position of the old ones from which the new ones spring; they are mainly transverse in the outside callus, because they converge from all points on the exterior towards the fractured spot; and they are longitudinal in the intermediate part when this is once developed, because the old ones lie above and below. Both kinds are usually present: but if a fracture is well set, especially in an adult, and kept at perfect rest, the provisional may be wanting; and the definitive is sometimes absent, the two ends being merely ensheathed and fixed by the deposit of spongy bone around them.

Provisional callus is not thrown out, as its name implies, to act as a temporary support, until the definitive can appear and take its place. It is the real bond of union between the broken ends, an attempt to restore the strength of the part with as little delay as possible. If a splinter is detached from the side of a bone, and the periosteum replaced, the hollow is very soon filled with spongy callus, in great excess because its strength is so much less than that of the solid part that has been lost. The bone is weakened and an attempt is made to restore its strength as soon as possible; cancellous tissue can be formed almost at once, while compact cannot, but a greater quantity is required. By degrees, when the vessels in the old bone have had time to dilate, and buds of lymph can grow out from the Haversian canals, some of the newly-formed cancellous bone becomes compact and modelled on the old lines, and then the excess is removed by absorption and the original shape restored.

The same thing occurs in a transverse fracture. Soft callus is thrown out round the ends, because this can be done at once; and the bulk is greater to make up for its feebler strength. Later, when there has been time for the central ring to become compact, the outside part, having no further purpose, is removed, and the original shape regained.

The ossification of callus may be preceded by the formation of cartilage or not, but in any case it follows strictly the physiological type of normal growth.

The first deposit of lime makes its appearance on the tenth to the fourteenth day, in the layer of the periosteum that lies nearest to the old bone. Almost from the first, the cells that occupy this part are larger than the rest; many of them are stellate, with one or more nuclei, and all have a large amount of granular protoplasm. The lime is deposited around these, so that if the periosteum is stripped up from the old bone, this is not only porous, but rough, from a covering of little spines and points. Far away from the fracture, at the boundary of the unaltered periosteum, the callus is converted directly into bone, even in animals. The intercellular substance at a distance from the vessels becomes darker; granular patches make their appearance in it, and grow larger and larger until they join together; and a network of trabeculæ, enclosing spaces of the most irregular shape, is built up by degrees. In these lie the vessels, with the cells arranged in concentric masses around. Gradually more and more bone is deposited, layer after layer of cells becomes infiltrated with inorganic material, always closing in towards the centre, until at length the spaces become narrowed down into Haversian canals, lined with lamellæ of soft but true bone.

In dogs and rabbits a very large proportion of the callus, internal as well as external, is converted into cartilage. In infants, too, this takes place to a very considerable extent, but in adults only islets of it are formed here and there, close to the broken ends, rarely or never between them, or in the medullary canal. A great deal of it, however, is not true hyaline cartilage; near the periosteum it shades off gradually into fibrous tissue, and in other parts the ground substance differs from the matrix of true cartilage in the way it stains with carmine. In places, too, it becomes converted directly into bone, the cells becoming smaller and stellate, and lime being deposited in the substance between them. Only here and there are there true capsules, which, as in normal cartilaginous ossification, become replaced by vascular buds of small cells, growing in from the surrounding parts.

Absorption begins long before the process of ossification is complete, working in both directions, from the interior of the medulla, and the exterior of the callus, towards the shaft. Giant-cells are abundant, especially in the medullary part, but they may also be found here and there, under the newly-finished periosteum, and in the superficial layers of the callus, eating it away irregularly until, by slow degrees, it is reduced to its permanent dimensions.

The permanent form of the bone.—The lines upon which a bone is built, as shown by its shape, and by the direction of its trabeculæ, are governed by the strains it has to meet. After a fracture, if the ends are so accurately adjusted that the axis is not altered, the original shape and construction are restored, because the strains the bone has to bear after the accident are identical with those it received before. But if it is not well set, so that its two ends overlap or form an angle with each other, the forces may still be the same, but they no longer act in the same way. The shape becomes modified, even that of the old bone, and the lines are altered to those which, under the circumstances, are best adapted to the work; and it often happens that they are very different from the original ones (fig. 94).

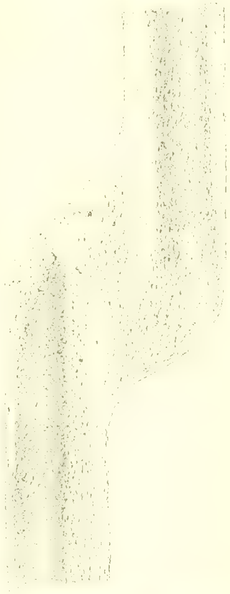


Fig. 94.—Badly united fracture of femur showing the displacement of the medullary canal and the immense increase in density and strength of the bone along the line of direct pressure.

If the ends are in apposition, but form an angle with each other, the medullary canal may be re-established, but it will not lie in the centre. The compact tissue on the convexity is thinned; that in the concavity becomes thicker. If they overlap, the central cavity is never restored, each end remaining sealed. The adjacent surfaces of bone either fuse together or are held secure by periosteal cellus. Often they become cancellous, because the transverse section of the whole is so much larger that porous bone is strong enough for the work; and the trabeculæ, both in the old and the new bone, become arranged in curves, as regular and as even as those in the neck of the femur.

Intra-articular fractures.—Repair is frequently imperfect when the line of fracture lies inside the synovial cavity of a joint; either bony union does not take place, or perfect freedom of movement is not regained. The extravasation is the first obstacle. Sometimes the blood collects in the interior, and, as in transverse fractures of the patella, forces the two fragments so far apart that no bridge of callus can be formed between them; or it coagulates and lies for weeks between the broken surfaces, so that it is impossible to bring them together. In other cases it lines the interior of the cavity like a false membrane, and interferes with its secretion; or it makes the capsule stiff and unyielding, and it may even, as Hunter first suggested, remain detached and form the nucleus of a foreign body.

Then the amount of callus thrown out is frequently deficient. None is formed by that part of the bone which is covered with cartilage, and very little, as a rule, by the periosteum inside the joint. In some bones, according to Bidder, there is no osteogenic substance here at all, the fibrous layer merely being continued from the shaft to the cartilage of the epiphysis. The only part that takes any active share is the broken surface, and, unless the ends are held absolutely in contact by impaction or other means, this is not sufficient, and either union is fibrous or it fails altogether, and the surfaces become dense and hard from long-continued friction.

This is certain to happen if one fragment is very small, or if, as in intracapsular fractures of the neck of the femur, it is cut off from its blood-supply. The chief nutrient vessels of the head of the bone enter the under surface of the neck; the branch running with the round ligament, even if it does reach so far, is not large enough to be of much service, and consequently, though it does not undergo necrosis, the vitality of the fragment is so feeble that, unless there is impaction, union never takes place.

Fractures through cartilage.—In the case of the costal cartilages the broken ends are generally held together by a ring of fibrous tissue, formed from the perichondrium and the cellular tissue outside it. Sometimes this is converted into bone and the cartilages themselves are calcified. In young subjects it seems probable that the cartilage corpuscles at a little distance from the seat of injury take some share in the process; those immediately bordering on it break down and disappear.

When the articular cartilage of a joint is split, as in T-shaped fractures, the cleft is filled in after a time by fibrous tissue; and the same thing happens, only very slowly, when a portion is completely detached, the fragment itself remaining as a foreign body.

2. *Union in compound fractures*

In compound fractures the process of repair depends upon the behaviour of the wound. If this heals by the first intention, or if it is sealed successfully, the tissue-changes are essentially the same as those described already. A certain amount of blood is extravasated, some of the tissues are disorganised and require to be repaired or replaced, but unless the crushing is so severe that the part sloughs *en masse*, the débris is carried away little by little; granulation-tissue grows into the space that is left, and fills it, and there is only a slight degree of hyperæmia and swelling, corresponding to the increase in the activity of the circulation.

If, on the other hand, the breach of surface is not closed in at once, union takes place more slowly, and is attended by suppuration of a more extensive character. In the slighter cases, in which the soft parts are not much bruised, or the bone splintered, and in which there is free exit for all discharges, the wound soon begins to fill. The vessels dilate, lymph pours out into the periosteum and the loose tissues around, until they are so swollen that it is not easy to distinguish one from another; the fibrin coagulates on the surface, the serum drains away, and as the new vessels are formed the broken ends of the bone become surrounded and enclosed by a mass of vascular granulation-tissue which grows until the cavity is obliterated. At first the surface of the bone, if the periosteum is stripped off, shows but little change; in a few days a number of minute red dots appear upon it; then each of these enlarges into a little bud of vascular granulation-tissue, springing from the side openings of the Haversian canals; and at length it becomes as porous as the cancellous part, and is covered over with a layer of vascular lymph, continuous with that formed from the structures around.

The granulation-tissue is converted directly into bone, without passing through any intermediate stage, and without the formation of cartilage. The lime salts make their appearance first, as in simple fractures, between the cells on the surface of the old bone at the boundary of the injury. From this they advance by degrees towards the injured part, until each of the fragments is surrounded by a ring of soft, spongy callus. These gradually increase in size, approach nearer and nearer until they join across, and unite at length with that which is developed from the medulla. The shape at first is very irregular, and the amount excessive, while openings persist here and there in the newly-formed sheath for the discharge of pus: but if there are no sequestra these soon close in and the whole becomes firm and dense.

In many cases, however, the result is not so fortunate. Sometimes it is due to the severity of the original injury; even in simple fractures it occasionally happens that the parts are so crushed and bruised that they slough; much more often it is the result of some fresh, additional, cause. The wound itself is of a peculiarly unfavourable character; nearly always it is deep and irregular in shape, divided by the layers of fascia into many strata, the openings of which do not correspond; the external orifice is often small while the internal cavity is always a great deal larger than it appears to be, and it is filled with a material exceedingly prone to decomposition. If this occurs before the barrier of lymph is thrown out, the products poison all the tissues near, inflammation of the most intense description follows, and unless checked in time spreads up and down the limb until it is thoroughly disorganised, or life itself is lost. The periosteum and medulla quickly become involved; in the neighbourhood of the wound itself, where the process is most intense, they may be completely destroyed. Splinters perish at once, and are thrown off; the ends of the bone, deprived of their blood-supply, undergo necrosis, and enormous masses of callus are thrown out round them by the more distant parts which suffer less.

If this happens, when nothing worse results, months often pass before union is complete. A line of demarcation must form round the necrosed fragments; granulations must be thrown out by the living compact bone, before the sequestra can be moved; and often, long before this takes place, callus has grown round them, and locked them in, so that an operation is necessary to release them. I have known them work their way out more than fifty years after the original injury. Firm union is often established months before the wounds have closed, and sinuses leading down to the interior of the bone sometimes persist for the rest of life.

Imperfect Repair

The amount of callus thrown out may be excessive. This is more likely to happen after compound fractures, or when there is a large number of splinters, and the tissues around are much irritated. As a rule, it is not of material consequence; the outline of the limb is altered, and the action of the muscles slightly impaired; but the inconvenience is not great, and the excess is soon removed by absorption. Sometimes, however, a nerve is compressed, and paralysis cr wasting sets in; or a joint is locked and useless, owing to outgrowths of bone around it; or two parallel bones, such as the radius and ulna, are joined together so that pronation and supination are lost. When this occurs, more active measures are required, and it is generally necessary to cut down upon the offending portion and excise it. These cases of overgrowth must be clearly distinguished from *callus tumours* (enchondromata and osteomata chiefly), of which a very few have been recorded, occurring, for the most part, at a much later period.

Occasionally, the callus becomes soft again, and is absorbed to a great extent, so that the deformity reappears. This may be due entirely to local causes—necrosis, for example, taking place at the seat of injury; or it may happen during an attack of erysipelas, and in the course of acute specific fevers. In one or two extraordinary instances the absorption has not been limited to the callus, but has extended to the fractured bone itself. As a rule, only recent fractures, in which consolidation has hardly taken place yet, are affected.

It is more common for the amount to be deficient from the first, or for the process of ossification to fail. Bony union, then, is either delayed, or else never takes place at all; no distinct line can be drawn between them; the causes that occasion the one will, if they act with sufficient persistence and vigour, equally give rise to the other.

1. *Delayed union*, as might have been expected, is met with much more frequently than complete failure. In simple fractures of the leg it is not uncommon to find, at the end of four or five weeks, that the fragments are apparently unaltered, as easily moved as they were at first. Sometimes a definite cause can be found; but more often there is nothing of the kind. Generally in these cases there has been very little displacement, with little injury to the surrounding parts, and consequently the amount of provisional callus is exceedingly small. Or the fragments may appear to be united, there may be no pain or undue mobility when the limb is tested; but a few days after the patient is allowed to get up the union begins to bend, and it is clear that the callus is not sufficiently firm. In the vast majority of instances this gets well of itself; the limb is straightened; a fixed apparatus, rather stronger than usual, is applied; and the patient is allowed to get about on crutches, with a strict injunction not to let the injured limb touch the ground under any circumstances; but every now and then the reverse takes place, the callus becomes absorbed from too early movement, the union becomes weaker and weaker, and a false joint results.

2. *Non-union.*—When there is no bony union at all, the ends may remain separate and distinct, without so much as a band between them; or they may be connected together by fibrous tissue of various degrees of strength;

or they may lie in apposition, held by a capsule of connective tissue, so that a more or less perfect joint is formed.

(*a*) *Absolute non-union* is rarely met with except in intra-capsular fracture of the neck of the femur, and in some cases of fractured patella. It is nearly always due to wide separation of the fragments. The medullary spaces become closed; the ends become rounded and wasted; the surfaces, if they are in contact with other hard structures, become dense and polished; and the callus that is thrown out after the fracture is absorbed again.

(*b*) *Fibrous or imperfect union* is much more common. Sometimes it is exceedingly firm; the ends of the bones are well nourished; the broken surfaces face each other; the fibres that pass across are short and strong, with perhaps islets of cartilage and even of bone scattered among them, so that it is difficult to be certain that perfect union has not taken place. Sometimes, on the other hand, the fibres are long and weak, formed rather by a condensation of the connective tissue around the ends than from a layer of callus directly connecting them; and the bones are thin and conical, with their ends much wasted. Every grade, in short, may be found, between union that is nearly as strong as bone and absolute failure.

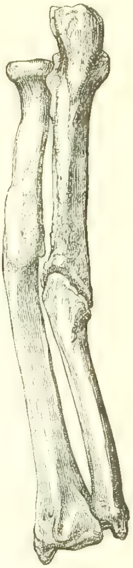


FIG. 95.—Ununited fracture of ulna.

(*c*) *False joints* (pseudarthroses), strictly so-called, are rarely met with. They appear to be formed out of false union in simple fractures by constant movement for months together. In some cases they are almost perfect; the ends are moulded so that they fit each other accurately; they are surrounded and held together by a tough ligamentous capsule; this is lined with a layer of flattened connective tissue corpuscles like an endothelium, and is filled with a fluid which, as in the case of adventitious bursæ, closely resembles synovia. Sometimes islets of cartilage, hyaline or fibrous, may be found upon the apposed surfaces, probably the remains of the callus that was thrown out shortly after the fracture. More often the surface is dense and polished, as in joints affected with arthritis deformans; and lips, fringes, and even loose bodies are occasionally found around the margin. False joints of this description are most frequently met with in the humerus and femur, possibly owing to the peculiarly dense character of the compact tissue.

They have been known to occur in children, especially in the leg, and to lead to impairment in the growth of the limb. When they occur in adults, the bones and muscles are often well-nourished, much better than they are in cases of fibrous union.

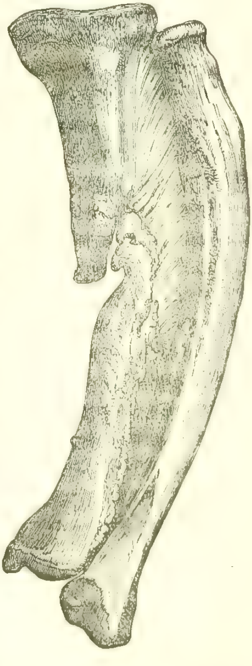


FIG. 96.—Ununited fracture of tibia with consecutive bending and strengthening of fibula.

Causes.—The causes of delayed union and false joints may be general or local; but the latter are by far the more important.

1. *General causes.*—Very few can be regarded as more than occasional; union is sometimes delayed; but more often than not it takes place as quickly as in health. Fevers, Bright's disease, diabetes, scurvy, starvation, advanced syphilis or carcinoma, pregnancy, lactation, any severe cachexia, in short, may check the progress of repair, but though undoubted instances are recorded, it is rare to find that any one of these is sufficient by itself. Sometimes the urine has been found to be alkaline and loaded with phosphates, and it has been thought that this was the reason, and in a very few cases it has seemed as if the fault lay with the nervous system. Old age is certainly not a cause; fractures unite as well in people over seventy as in younger ones, with the exception of intra-capsular fracture of the neck of the femur, the reasons for which are probably entirely local. Complete failure may nearly always be traced to local causes.

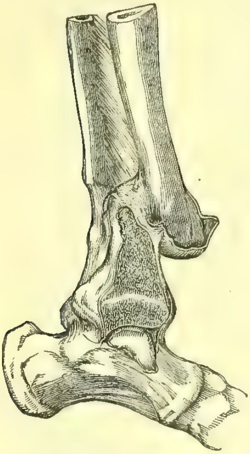


FIG. 97.—False joint in tibia from a fracture probably at birth.

2. *Local causes.*—Some of these, like the general ones already mentioned, merely delay union; others prevent it altogether; but with a few exceptions it cannot be said even of these that they are invariable; and in a large proportion of cases it is impossible to give a definite reason why union fails.

(*a*) *Separation of the broken surfaces.*—This is the most important; if the space between the fragments is filled up with other structures, whether muscle, tendon, joint-capsule, or blood-clot, so that they cannot be brought together, failure is almost certain. It does not matter how the separation is produced; the ends may be driven into the substance of other structures near; or drawn apart by the action of muscles; or made to overlap so that the periosteal surfaces only are in contact; unless they are properly adjusted

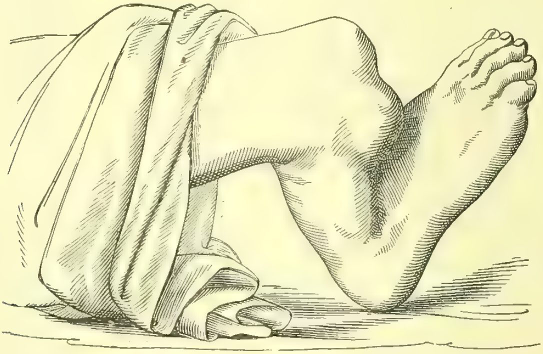


FIG. 98.—Position assumed by the limb in this case before it was amputated.

the result is almost certain. Non-union is more frequent in compound fractures than simple ones, owing to the amount of bone that is sometimes lost by resecting the ends, or from necrosis.

(*b*) *Movement.*—In other instances the method is in fault; either the fragments are not properly secured, and the neighbouring joints not fixed as they should be; or movement is allowed too soon, and the callus is absorbed again. This happens in a variety of ways: the bandages may become loose from shrinking of the limb; the patient may be delirious; surrounding circumstances may be unfavourable; or a neighbouring joint may become stiff, so that when the limb is used an undue strain falls upon the seat of fracture. One of the favourite sites is the middle of the shaft of the humerus, and it is certainly not uncommon to find in these cases that the elbow is stiff; but I am disposed to think that more importance should be attached to the peculiarly dense character of the bone at this spot, and to the possibility of slips of the neighbouring muscles getting in the way. In the case of sailors, among whom cases of ununited fracture are unusually frequent, full allowance must be made for defective hygienic conditions, although, admittedly, fractures of the ribs rarely fail to unite in them.

(*c*) *Malnutrition.*—The prolonged application of cold; ligature of the main artery; tight bandaging so as to interfere with the circulation; thrombosis of the veins leading to œdema, and rupture of the nutrient vessels, are all cited as occasional causes; and no doubt they are not without some influence, although it is difficult to believe they are sufficient of themselves. It has not been proved that the nerves exert any direct effect.

(*d*) *Disease of the bone itself* is an occasional cause. Necrosis has been already mentioned as especially frequent in compound fractures; but tertiary syphilitic nodes, mollities ossium, atrophy, hydatid cysts, sarcomata, and chronic abscesses sometimes lead to the same result.

Diagnosis.—This rests mainly upon the degree of mobility that is present. In cases of delayed union it is usually slight, though the amount of deformity may be considerable, and it is always painful; in fibrous union or false joint, on the other hand, it is free and nearly painless. The probability of the latter increases greatly with the length of time since the accident; but union of a fractured femur has been known to take place without operation after as long an interval as twenty-two months.

Treatment.—Like the causes, this is general as well as local; but while the former may prove serviceable in mere delay, it is entirely without effect in genuine cases of false joint.

1. *Constitutional.*—This naturally varies with the requirements of each case. Nourishing food and fresh air are essential in all; tonics are often needed to improve digestion; a fair amount of stimulants is advisable, especially in those who are accustomed to them; and iron, cod-liver oil, and other remedies may be given to improve the general health; but there is no proof that the administration of lime or of phosphorus in any shape has any effect upon the deposition or the ossification of callus. In cases of syphilis, mercury and iodide of potash must be given according to the general rules; and mercury has been given experimentally with success where no history could be obtained; but, apart from the presence of gummata upon the bones, it very rarely happens that union is in any way delayed by this disorder. Vegetables and lime-juice are equally important if there is any suspicion of scurvy; and a woman who is suckling should be

directed to wean her infant; but, beyond general considerations of this character, nothing can be done. There is no evidence that any drug has the least direct influence on the rapidity with which union takes place.

2. *Local.—Readjustment.* The first thing, if the ordinary time has elapsed and the fragments are still movable, is to reset them, bring them into apposition with each other, and secure them in some form of splint (a fixed one generally) that will ensure absolute immobility, and at the same time enable the patient to get into the open air. This alone is sufficient in a large proportion of cases, especially those in which the chief cause is want of rest. Only it is necessary to make certain once for all that the fragments are really in apposition, and that nothing has slipped in between. Should this have happened, union is almost certain to fail; and unless the ends can in some way be disengaged and brought together, it is scarcely worth while wasting time in trying measures that must be ineffectual.

Counter-irritation.—This may be combined in some instances with the use of counter-irritants—tincture of iodine, for example, painted one very night, or light blisters. These no doubt do increase the amount of blood flowing through the parts beneath; the exact form of a blister painted on the thorax may be traced sometimes upon the costal pleura; and where a bone is near the surface, as in the case of the leg, the periosteum would almost certainly be stimulated to increased action; but at the best they can only be of very limited application.

Mechanical stimulation.—If this procedure fails, an attempt may be made to excite a certain degree of inflammation by friction or percussion, and then to obtain union by securing the fracture in a plaster case. One method is to rub the ends of the bones together every day, until a certain amount of heat and swelling is produced around the seat of fracture. Another aims at the same effect by hammering them with a mallet, the skin being protected from injury by a piece of felt. A third, which is sometimes successful, not only in delayed union, but even in case of false joint of long standing, consists in encasing the limb in an apparatus so contrived that the patient may get about, while the fragments are held rigidly fixed and in contact with each other. This is especially useful in fractures of the lower limb, where there is already a fair amount of union, and where the direction is not too oblique. The appliance, which must be worn night and day, naturally must be fairly strong, and must fit with the greatest accuracy. The best are made of leather, with lateral iron supports, jointed in the proper situations, and let into the boot beneath. The health of the patient improves; the nutrition of the limb becomes more satisfactory; and the constant friction of the ends of the bones stimulates them to such an extent, that in many instances the fracture unites and becomes firm without anything further being required.

Puncture and injection.—When it is no longer a question merely of delay, the same kind of treatment may be adopted, but in a more vigorous manner. If the bone lies near the surface, it sometimes answers to drive a number of stout needles directly through the skin into the space between the fragments, and leave them there for a week or ten days. In other cases the injection of various kinds of fluid, tincture of iodine, carbolic acid, and alcohol has been tried. Or the negative pole of a galvanic battery has been attached to a needle inserted between the fragments, and a current as strong as the patient could bear without an anæsthetic passed through it; or the ends have been scarified with a tenotome, or perforated with a drill, with the view of exciting sufficient inflammation about the part to fix the fragments in the exudation. None of these, however, can be advocated very strongly; acupuncture and drilling the ends are perhaps the most satisfactory, but they are not so devoid of danger as they seem to be, especially as the large blood-vessels are often adherent to the fragments, and their action is by no means certain. Setons should certainly not be used.

Pegging.—Of all the methods that act in this way, the one that has enjoyed the greatest amount of success is that first practised by Dieffenbach. According to his directions, a small incision is made through the soft parts down to the bone, on the side that is most accessible, and both fragments are drilled completely through; then an ivory peg is driven into each with a wooden hammer, until its end can be felt projecting on the other side, and the fracture secured in a plaster casing. The pegs may be left in for ten days or a fortnight, according to the amount of reaction they cause.

It is generally found when the pegs are removed that the surface is deeply eroded (after the fashion of Howship's lacunæ) by the cells in the medulla; and it is much simpler to break them off short, and leave them in the substance of the bone, to be absorbed there; they do not of themselves excite suppuration, the skin wound can be closed at once, and there is much less chance of inflammatory complications setting in. In very oblique fractures, where the ends of the bones overlap, an additional amount of security may be obtained by driving the pegs through both, so as to pin them together; and steel screws may be used in the same way, the handles being detached after they are fixed, so that the whole can be covered up in one dressing; but if measures of this kind are adopted, it is more satisfactory to expose the ends of the bone thoroughly, resect them if necessary, and adjust them accurately. The operation is scarcely, if at all, more severe, and the result is decidedly more certain.

Resection and wiring.—In a large number of cases this is the only plan that offers a reasonable prospect of success. Where there is a false joint of long standing, or great displacement of the ends, or when some foreign substance has become entangled in the fracture so that the bone cannot be released, nothing else can be of any avail. The immediate neighbourhood of a joint is no objection; if the tissues themselves are healthy, and if there is no great amount of inflammatory exudation around the part already, there is no reason why suppuration should occur. A certain amount of stiffness may result, it is true, either from the formation of adhesions, or from excess of callus, but it is rarely of any extent, and of course such an operation as this is not done unless the usefulness of the limb is seriously impaired.

The operation itself, especially in the case of a deeply-seated bone, is by no means easy. The limb is rendered bloodless; the parts thoroughly exposed by a longitudinal incision, if possible through one of the inter-muscular septa, so as to avoid injury to other structures; all intervening tissue removed, taking especial care to preserve every fragment of periosteum, and the ends either sawn off or thoroughly freshened. It is of little or no use unless they are made to fit each other accurately, over a surface of some extent, and are firmly held together. They may be secured in various ways according to their shape; sometimes, when they are both oblique, they may be pegged through with wire or ivory needles; in other cases they may be dove-tailed or wedged into each other; in one example the lower end of the fibula was driven into the medullary canal of the upper end of the tibia, with a very good result; or if the central canal of both fragments is exposed, an ivory peg may be fixed, first in the one and then in the other, so as to hold them in the same straight line; but the ordinary method is to drill them both, and suture them together, either with silver wire (the ends of which can be hammered down), or kangaroo tendon. Especial care must be taken to provide sufficient drainage; owing to the amount of manipulation to which the parts must be subjected in an operation of this kind the oozing is in general very extensive.

Even this is not always successful. A great deal depends upon the condition of the bones; if they are much wasted, and if the ends are sharp and pointed, failure is not at all unlikely. Sometimes, when a first attempt under strict antiseptic precautions does not succeed, a second without is more satisfactory, and union has taken place after an attack of erysipelas. Perhaps the best thing, if the operation fails, is to put the limb up in some apparatus that will allow it to be used to a certain extent, in the hope that, though this may not improve the chance of union, the bones will be better nourished, and then another attempt may be made later on.

Transplantation.—Nussbaum, in two instances in which there was a great deficiency in the ulna, separated a portion of bone from one of the ends, leaving it attached by periosteum, and reflected it, so that it filled up the interval. If this is attempted, the circulation through the bone must first of all be stimulated by inserting needles into it, and great care must be taken to prepare the bed for the new fragment.

Grafting.—MacEwen has carried the process farther still, and by dint of repeatedly grafting in fragments of bone obtained by osteotomy, succeeded in a child three years old in causing the reproduction of nearly the whole of the shaft of the humerus. Fragments of bone and periosteum obtained from animals have also been used, and with success; in one instance a gap of two and three-quarters inches in the clavicle was gradually filled up by grafts of bone from dogs, three successive series being used; and in another (McGill) thirteen fragments of bone from the femur of a rabbit were transplanted into a gap in the radius with a perfect result. It is possible, of course, that this may be due merely to the irritating effect of a foreign body; but it is difficult to believe that the nature of the foreign body is of no importance.

Symptoms and Diagnosis

A fractured limb must be made secure at once to avoid further injury. Full and detailed examination is better postponed until the splints and other appliances are ready, that the fracture may be set without being handled a second time. The extent to which it is advisable to carry the investigation and the question of an anæsthetic vary in each case, and must be left to the discretion of the surgeon. In some instances, such as fracture of the neck of the femur in an old person, manipulation should never be attempted; on the other hand, in an injury to the lower extremity of the humerus, it is absolutely essential to find out the exact position and direction, if serious deformity is not to result.

The possibility that neighbouring structures, especially arteries and joints, are injured too, should never be forgotten, and a careful examination into their condition should be made in every case; they may easily be wounded by splinters and in other ways, and if overlooked may lead to very grave complications.

Method.—No pains should be spared to obtain a clear account of the accident, whether the injury was the result of direct or indirect violence, or if it was due to muscular action—sometimes a sound is heard at the moment that the bone gives way—then what happened afterwards, whether the limb was used again, or if all power over it was gone, and where the pain was most acute. In many cases a shrewd suspicion may be formed from this alone, not merely as to the part of the body which has been hurt, but even as to the kind of injury sustained.

Then, before it is touched further than is required for the removal of the clothes (which should be cut wherever necessary), it must be inspected with the greatest care, and compared, point for point, with the corresponding part of the opposite side. Often the position is characteristic of some special kind of injury; sometimes the outline is greatly changed, natural hollows perhaps are obliterated, or bony prominences have disappeared, or measurement even by the eye reveals an amount of shortening or displacement that can be accounted for in no other way.

Not till this is finished may the part be handled, and then as lightly as possible, beginning at some distance from the supposed seat of injury, and tracing down with the finger the prominent ridges or crests of bone. One spot may be more tender than the rest; nearly always there is swelling either from the extravasation of blood, or from displacement of the broken ends; sometimes there is discoloration, or the skin is abraded and even torn. All this must be noted before any attempt is made to move the part, either for the purpose of eliciting crepitus, or of ascertaining the presence of abnormal mobility. This, if it cannot be avoided altogether, must be postponed to the last. It must never be forgotton that in all cases a great deal (in fractures by indirect violence nearly the whole) of the injury sustained by the soft parts is due to the movement of the broken ends.

Symptoms.—The three distinctive signs of fracture are an alteration in the shape of the part due to the displacement of the broken ends, undue mobility, and the rough grating sensation, or crepitus, felt when one broken surface is rubbed against another. The presence of any one of them is enough; when they are all three wanting, as in fissures of the cranium, the existence of a fracture is only a matter of inference.

1. *Deformity.*—Of these three displacement is the most valuable, as it requires little manipulation, and is the one most often present. Sometimes it is so considerable that it is visible to the eye at once; more often it can be felt beneath the skin, but in most instances it is only possible to make certain by means of measurement. In the limbs, comparison with the opposite side of the body is an absolute rule. In some cases a fairly accurate estimate may be made with the hands alone, grasping, for example, the anterior superior spines of the ilium, in a case of injury to the upper extremity of the femur, and measuring with the fingers the relative position of the trochanters on each side. In general, as the displacement is so often longitudinal, it is done much better with a measuring tape or a sliding graduated rod. The points selected on the two sides should be well marked, and must absolutely correspond; the position of the limbs must be

identically the same, and as asymmetry is not at all uncommon, it is often advisable to measure not only the length of the whole limb, but that of the individual segments. This is particularly necessary in the lower extremity; whether from previous injury or disease, or from some difference in the rate of growth, it is not at all uncommon to find one of the lower limbs considerably longer than the other.

The direction of the displacement depends chiefly on the character of the part that is injured. It may be angular as in a greenstick fracture; transverse or lateral when a flat bone is concerned; circular as in fractures of the lower extremity with eversion of the foot; or longitudinal, the ends either being drawn apart as in transverse fractures of the patella, or approximated so that they lie side by side and override each other. In some cases, when, for example, one is so driven into the substance of the other that it becomes impacted there, deformity is the only one of the three cardinal symptoms present; occasionally it is absent, as in fissures of the cranium, or when only one of a pair of bones is broken.

In impacted fractures the displacement is entirely the result of the original force; in other cases it depends to a great extent on causes which continue to act after the bone is broken, so that it grows worse and worse the longer the fracture is left to itself. The most serious is the contraction of the muscles; not merely the tonic shortening which results naturally as soon as they are released from their state of tension, but violent and continued spasmodic contraction, due no doubt to the irritation caused by the broken ends. This is responsible almost altogether for the separation when a bony projection is wrenched off and for the shortening which is nearly invariable in fractures of the long bones of the limbs; and therefore, in cases of paralysis, displacement is always slight. In other injuries the weight of the limb, and what is a great deal worse, subsequent attempts at moving the part either by the patient himself or by others, often add seriously to it. Indeed it is in great measure owing to these two last-mentioned causes that so many fractures by indirect violence become compound.

2. *Abnormal mobility.*—Abnormal mobility, when it is present, is conclusive, but if the degree is slight, or if the fracture is in the neighbourhood of a joint, it is very hard to appreciate, and if there is impaction it is wanting altogether. It is most plain in transverse fractures of the shaft of long bones where there is only one; in injuries of short bones or where one fragment is so small or so deeply placed that it cannot be fixed, it is of little or no assistance, and though it is nearly always present when one of a pair of bones has given way, special manipulation is generally required to show it. If, for example, the radius is in question, the thumb of one hand must be placed upon the head of the bone, while the other alternately pronates and supinates the forearm; if the lower end of the fibula, a finger must be pressed firmly on the suspected spot, while the upper part of the two bones are squeezed together or the foot is forcibly inverted and everted.

Manipulation of this kind must be carried out with the greatest gentleness, not merely because it is so painful (this may be prevented by an anæsthetic) but because it inflicts such injury on surrounding structures. For this reason in some fractures, of the spine for example, any attempt should be absolutely prohibited.

3. *Crepitus.*—Crepitus, the peculiar sensation, partly felt, partly heard,

when one broken surface is made to rub upon another, is still more limited in its application, for in order to produce it the fragments must not only be freely movable but in actual contact, or at least so close that they can be made to touch. If they are fixed or widely separated, or if a piece of fascia or muscle, or even blood-clot has slipped between, it fails completely, and when an epiphysis is detached, especially in very young children, it is so soft and faint that it can scarcely be recognised. Other sounds too resemble it more or less closely; if a synovial sheath or bursa is inflamed, or if there is a collection of extravasated blood beneath a layer of dense fascia, such as is not uncommon in the region of the shoulder, direct pressure may cause a sensation that is almost identical; but, as a rule, it only does so once, and the sensation cannot be repeated at the same spot till some little time has elapsed. Single clicks too, something similar in character, may often be felt near joints that have been injured when they are moved in certain directions; and sometimes, as in the elbows of children, in whom the bony prominences are naturally low, and often still further concealed by swelling, they may be so clear as to cause a momentary doubt.

In rheumatoid arthritis, when the cartilage has disappeared from the articular surfaces, and the polished bones are rubbed upon each other in every movement of the joint, the sound is almost identical, but the feeling is much smoother, and the surfaces do not grate on each other in the same way.

The sudden sound that is sometimes heard at the moment of the accident, not only by the patient, but even by those standing near, is rarely of any assistance in diagnosis, as it only occurs when a long bone is broken, in circumstances that nearly always cause much displacement.

Pain.—In addition to these there are other symptoms which are not confined to fractures, and which therefore can only be regarded as proof when there is other evidence in support of them. Intense pain at the seat of injury, for example, is nearly invariable, but to be of any use in diagnosis it must be constant and limited to one particular spot. If, for example, pressure on one part of a rib always causes pain at another; or if after the foot has been twisted an exceedingly painful spot is found on the fibula an inch or two above the ankle-joint, fracture more or less complete is almost certain; there is nothing else that can explain localised tenderness so far from the seat of injury.

Ecchymosis.—Extensive ecchymosis again is a common occurrence in cases of fracture, but is of little use in diagnosis unless it has the support of other signs. Hæmorrhage from the ear, for example, is generally present in fractures through the middle fossa of the skull, but it is only conclusive when it is sudden and profuse; and staining of the skin is not in any way peculiar unless it is accompanied by localised tenderness and it is certain that the part itself was not directly hurt.

Helplessness.—Inability to make use of the part is very general, but by no means invariable. It depends of course upon the size and importance of the injured bone and the extent to which it is hurt. If the ends are impacted, or the periosteum is not torn, or if only one bone of a pair is broken, the limb may still be used to a certain extent, though not without pain. In some cases of fracture of the clavicle it is quite possible to raise the arm above the head, and persons with impacted fracture of the neck of the femur have been known to walk about for days. When, on the other hand, the bony support for the leverage of the muscles is lost, this is absolutely impossible. Unhappily, this symptom is not confined to fractures, but is present in other injuries too, particularly in those which present the closest resemblance to them.

Diagnosis.—The diagnosis of fracture has to be made from separation of epiphyses, dislocations and contusions. Injuries in the neighbourhood of joints therefore present the greatest difficulty, and if the examination is delayed until swelling has set in, or if the joint has been previously the seat of disease, particularly of rheumatoid arthritis, it may be necessary to wait for some days and to watch the progress of the case before a definite opinion can be given. In such a case the injury must always be treated as if it was certain that the bone was really broken.

The separation of an epiphysis is distinguished by the locality, by the age at which it occurs, and by the peculiar soft character of the crepitus, when it is present: in infants it may be absent altogether, as the line of detachment in them lies in the substance of the cartilage. The amount of displacement is rarely very great, as the periosteum belonging to the shaft is closely attached to the epiphysis, and is so tough that it is seldom torn completely in two; but sometimes, when the end of the shaft is near the skin, its smooth and rounded shape can be distinguished from the sharp outline of a fracture. The diagnosis is important, because in a certain number of cases this accident is followed by an arrest of growth, and it is advisable that the possibility of such an occurrence should be pointed out at the time. When there is only one bone, as in the arm, there is merely a certain degree of shortening, and if the upper end is in question some restriction in overhand movements; but when the lower end of the radius fails to grow the styloid process of the ulna projects farther and farther until the use of the hand is seriously interfered with and the appearance is very unsightly.

Dislocations rarely present any difficulty if the injury is seen shortly after the accident, before swelling has set in and the bony prominences are obscured. If displacement is once rectified there is no tendency for it to return; true crepitus is wanting, though sometimes there is a very fair imitation, and there is no abnormal mobility. The position of the limb is fixed, and can only be altered by the exercise of a certain degree of force. It must not be forgotten, however, that fractures sometimes occur with dislocations, and that, particularly in the case of the elbow, fractures into joints may be accompanied by a degree of displacement that produces a very close resemblance.

Severe contusions, in which there is complete loss of power over the limb or a considerable extravasation of blood, in many cases cannot be distinguished from impacted fractures, and should be treated as such. It is impossible to prove that the crushing force has been expended entirely on the soft parts and has not reached the bone, without handling the part to an extent which, in such injuries, is certainly not advisable.

COURSE AND GENERAL COMPLICATIONS

Shock—All fractures of any consequence are attended by shock and followed by a certain degree of fever. The former of these is dependent, not only on the fracture itself, but on the extent of the injury the soft parts have sustained, the way in which the accident happened, and the condition, mental as well as bodily, of the patient at the time. I have known a man whose great toe was run over by a railway engine, so collapsed that twenty-four hours passed before the reaction was sufficiently good to justify an operation.

Retention.—Retention of urine for a day or two is present in a large number of cases, especially when the fracture involves the pelvis or the femur, and when the patient is confined to bed.

Fever.—In simple fractures, and in compound ones in which the wound heals by the first intention, the fever rarely reaches any height. It is traumatic fever in the strictest sense of the term. The same evening there is, generally speaking, a fall of temperature due to the shock ; the next day it is slightly raised, and it reaches its maximum, 100° or 101° F., by the evening of the second day. To some extent it is due to the pain and tension upon the sensory nerves of the part, and, as a rule, it is proportionate to the amount of extravasation ; but the main cause is the gradual absorption into the circulation of the blood ferment set free by the injured tissues, and the broken-down clot which fills the wound.

If, on the other hand, the fracture is compound and the wound does not heal by the first intention, or if, as very rarely happens, the limb is so injured that, though the skin is unbroken, it becomes gangrenous, no rule can be laid down either as to the kind or the degree of the fever. It depends entirely on the complications that set in and the extent and severity of the inflammation by which they are accompanied.

Fat embolism.—Fat embolism occurs probably in every fracture. It comes, no doubt, mainly from the medulla, but as the amount found in the lungs is sometimes too great to be accounted for in this way, it may be derived to a certain extent from the subcutaneous tissue as well. Large veins are torn across, their ends are held open, the pressure in their interior is exceedingly low, that in the space around from various causes much higher, and as a consequence the contents of the broken fat-cells and the extravasated blood are taken up and carried away by the current. It commences almost at once. I found abundant evidence of its presence in the lungs of a man whose death was almost instantaneous from a broken neck ; and it continues for some weeks, the drops of fat circulating in the vessels becoming broken up as they pass through the capillaries, and reuniting again in the larger trunks until they are finally excreted by the kidneys.

The clinical significance of this complication has been very variously estimated. There can be no doubt that in the vast majority of instances it gives rise to no symptoms at all, and animals, at least, are not materially affected when four times the quantity of fat contained in a femur is suddenly injected into one of the larger veins. When the amount is greater than this, there is a conspicuous lowering of temperature, difficulty of respiration and evidence of heart-failure. The same symptoms have occasionally been observed after simple fractures in man, and may, with a fair amount of probability be assigned to this. Collapse is always prominent, not immediate, as if it were due to shock, but coming on after an interval of some hours ; the pulse is small and quick, respiration hurried and shallow, the temperature falls rapidly, the face becomes pale, there is a feeling of great weakness, the senses gradually become more and more dull until death ensues, perhaps preceded by convulsive attacks. In the case of compound fractures it is, generally speaking, impossible to decide how much is due merely to the mechanical influence of fat embolism, and how much to acute septic intoxication, which is frequently present in the same kind of case.[1]

It is a very old observation that sometimes after fractures an oily scum forms upon the surface of the urine after it has been allowed to stand, and it seems probable, when this happens, that it is due to the particles of fat which are excreted by the kidneys in a state of molecular subdivision. It is not common, however, for the amount to be sufficient to produce this effect. Oily and albuminous casts have also been described, but their presence is certainly unusual.

The further course of a simple fracture is, as a rule, quite uneventful. The swelling of the limb gradually subsides and becomes localised to the immediate seat of injury, where, owing to the callus that is thrown out around the broken ends, it may persist for months. The extravasated blood is slowly absorbed, the discoloration sometimes showing itself in far-distant parts of the limb. Occasionally blebs filled with serum, more or less deeply stained, make their appearance by the side of pads where there is little or no pressure. These should be pricked, their contents absorbed with wool or blotting paper, and carefully dried, or, particularly if there is much œdema, they may prove the starting-point for some inflammatory process.

Constipation is a very general complaint. It may be due to a slight extent, perhaps, to the fever, but mainly it is the result of the confinement to bed and the sluggish circulation through the liver. Sometimes it ends in an attack of gout or jaundice.

Congestion of the lungs and hypostatic pneumonia are often brought on in the same way, especially in old people, many of whom never really lie down at all. If they meet with any accident their circulation, already feeble, is so affected by the shock that passive congestion and œdema set in and rapidly prove fatal.

Bed-sores too, are very prone to occur from the same cause, especially if the patient is not kept scrupulously clean. Over the sacrum is the most common situation, but they may form anywhere over bony prominences if care is not taken in fitting the splints. The back of the heel, for example, is a very favourite locality in fractures of the leg, and a sore is sure to form unless proper precautions are taken. One great advantage of fixed apparatus is that by enabling the patient to sit up and change his position from time to time all these troubles due to rigid confinement are very greatly mitigated.

Tetanus has been known to occur in simple fractures, apparently from the stretching and bruising of a nerve by some fragment of bone. In compound ones it is more common, but it must be regarded rather as a complication of the wound than of the fracture. *Delirium* too, both delirium tremens and that form of wandering which is often met with in old or enfeebled patients after slight accidents, is of frequent occurrence in injuries of this kind, but is not in any way peculiar to them.

Special Complications

The local complications that occur in connection with fractures are immediate or remote. The former depend upon the injury inflicted on surrounding structures at the time of the accident, the latter result from the changes that take place subsequently during the progress of the case. Cases of injury to important viscera must be treated by themselves.

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[1] See Paper by author in *British Medical Journal* for July, 1881.

Laceration.—Laceration of the soft tissues and extravasation of blood are so general that they can scarcely be called complications, unless exceptionally severe. In simple fractures the skin is sometimes stripped up from the fascia beneath, and floats, as it were, upon the surface of a hæmatoma; but unless some large vessel has given way, this is readily checked by compression or position, and soon disappears of itself. Suppuration rarely occurs. In compound fractures the danger is greater, for if inflammation once breaks out, it is only too likely to spread along the track so well prepared for it; and in severe cases, where there is much laceration, and the extravasation extends along the limb, it is often a wise precaution to enlarge the opening, and even make fresh incisions for the purpose of washing out the extravasated blood, and securing effectual drainage.

Rupture of arteries.—When the main artery of a limb is concerned, the question is much more serious. It may be compressed by one of the fragments; the sharp edge of the lower end of the femur, for example, may be pressed against the popliteal; or it may be punctured by a splinter, or crushed so that the two inner coats give way and curl up in the interior of the vessel; or it may be torn completely in two. Sometimes, therefore, it is blocked, (though it may give way later), and sometimes it continues to bleed until it is stopped by the tension of the tissues around or by the failure of the heart.

If there is a wound, the nature of the complication is generally evident at once, though when the external opening is very small and tortuous the stream may be continuous instead of coming in jets. In simple fractures the symptoms depend upon the size of the artery and the nature of the injury. If one of the main trunks is torn across, a tense elastic swelling forms with great rapidity, there is the most excruciating pain, the pulse below is completely lost, and the limb becomes cold, œdematous, and numbed. If, on the other hand, there is only a puncture, so that the continuity of the vessel is not interrupted, this takes place more slowly; a certain amount of indistinct pulsation may be felt for a time, and sometimes, at least, a low murmur may be distinguished, synchronous with the pulse.

(*a*) *In compound fractures.*—In the case of a compound fracture, if the vessel is of any size or importance, the choice of treatment is very limited; either the wounded artery must be found and tied above and below, or the limb must be amputated. Which of these alternatives is adopted in any particular case depends upon the patient, on the particular artery that is wounded, and on the extent of the injury inflicted on the other structures around. Obviously, a much greater risk may be run with a child than with an adult, though children bear hæmorrhage badly; there is much more hope when the upper limb is in question; and the prognosis is much better when the fracture has been caused by indirect violence than when the soft parts are crushed, the collateral circulation destroyed, and the neighbouring joints torn open.

The hæmorrhage must first be checked by a tourniquet, or other means suited to the part, the wound enlarged, all clots turned out and a thorough search made. Sometimes this is successful, but finding a torn vessel under conditions such as these is always a matter of the greatest difficulty. Ligature of the vessel higher up cannot be recommended; if the collateral circulation is good, the bleeding continues; if it is not, gangrene sets in.

(*b*) *In simple fractures.*—In simple fractures the question turns upon the collateral circulation and the limitation of the extravasation. If the swelling is tense and diffuse, so that the limb below is cold and pulseless, amputation must be performed at once before gangrene sets in. The only exception is where the surrounding structures are but little injured, and the interruption to the circulation is due more to the tension than to the destruction of the collateral vessels. Occasionally this happens to the popliteal; an attempt may then be made, provided everything else is favourable, to find and tie the injured artery, but it must be recollected that this makes the fracture a compound one, and that very often it extends into the knee-joint.

If, on the other hand, the circulation is not completely interrupted; if the limb still retains some warmth and sensation, there is some hope either that a traumatic aneurysm will form, or that, better still, the wound in the artery may close, and the blood quietly become absorbed without further trouble. I have known this happen even when it was practically certain, from the extent of the extravasation, that the brachial artery had been torn across. The limb should be raised, kept quiet, placed in as comfortable a position as possible, and wrapped in cotton-wool to maintain the temperature. No firm bandages or splints may be applied, merely something to protect the part against incautious movement; the best hope lies in perfect rest and gentle compression.

In the case of the anterior tibial the symptoms sometimes disappear of themselves; more often the swelling continues to pulsate without extending very rapidly, and a wall, more or less perfect, is gradually formed around the hæmatoma until it becomes a traumatic aneurysm. This may be cured at any time by any of the ordinary methods; compression may be tried first; if this fails the artery may be tied above, or the sac may be laid open and both ends of the vessel secured. Careful examination for pulsation should be made in every case of localised swelling that makes its appearance after a fracture; very often there is a certain amount of redness and inflammation round a traumatic aneurysm, and many of them have been laid open in mistake for abscesses, especially as they are sometimes met with at some distance from the seat of injury.

When the posterior tibial is wounded, it is rare for the swelling either to subside or become localised. If the limb continues warm, digital compression of the femoral may be tried; at least it places the patient in no greater danger, for if gangrene supervenes amputation can always be performed at the seat of injury; and ligature in Scarpa's triangle has proved successful in a few instances. If, however, the swelling is rapid, and there is evidence of venous congestion; or if the part is plainly becoming colder, an attempt may be made to tie the vessel, but in all probability the limb will have to be amputated. When the popliteal is in question, owing to the space round the vessel, the swelling, as I have mentioned already, is always diffuse.

Rupture of veins.—Rupture or puncture of a large vein is a very unusual and a very grave complication. The popliteal is occasionally torn or compressed at the same time as the artery, and the subclavian is sometimes, but very rarely, injured in fractures of the clavicle; in other cases the vein usually escapes, unless the limb is utterly disorganised. The symptoms, with the exception of the pulsation, are almost the same as those of ruptured artery, and gangrene is even more likely to occur. If the limb is growing cold, the only course is to lay the swelling open, turn out all the extravasated blood, and try to secure the two ends as soon as possible, and failing this, amputate.

Secondary Hæmorrhage.—Secondary hæmorrhage may occur after compound fractures, just as it may after any other injury, and from the same causes. In addition, however, there is always the danger in simple as well as compound ones, that a loose splinter may be driven into an artery or vein by some incautious movement, or that the wall of the artery may ulcerate through from pressure. I have known this occur in the case of the popliteal a twelvemonth after the original accident; the lower end of the upper fragment was displaced backwards, so that it came into contact with the vessel and gradually wore a hole through its coats, long after recovery was thought to be complete.

Thrombosis.—Thrombosis of the veins is not uncommon after fracture. It involves most frequently the deep veins of the leg, especially in old people and those whose circulation is not very vigorous, starting either from the seat of injury or from some part where a vein is compressed or irritated by the edge of a bandage. The limb becomes œdematous, even before it is allowed to hang down; it pits with pressure (but only if this is firm and long continued), and it feels cold, heavy and helpless. When once this is developed, it is exceedingly obstinate; it may interfere with the union of the fracture, and it has been known to spread until even the vena cava became involved. If a fragment is detached, the consequences are exceedingly grave; so long as it is small, it merely causes a transient attack of dyspnœa, due to the blocking of a branch of the pulmonary artery; but when it is large, either the trunk of the vessel itself is suddenly occluded, or the embolus is coiled up in the cavity of the right ventricle. In either case death is immediate. When this occurs, there has generally been something to detach a portion of the clot, some sudden movement, either of the patient or the limb; and, consequently, it is most likely to happen when the fracture is nearly consolidated and the patient is beginning to move about.

Injury to nerves.—Large nerve-trunks are so strong that they are seldom torn, but they often suffer in other ways. They may be contused or wounded by splinters; sometimes they are caught between the bones so as even to prevent union, or they slip into a cleft in one of the fragments, or what is much more frequent, they are enclosed in the callus that is thrown out after the injury, and slowly but surely constricted until their physiological continuity is destroyed. More than half the cases on record refer to the musculo-spiral nerve; but, considering the rarity of fractures of the upper end of the fibula, the peroneal seems to suffer almost as often. The symptoms presented by this complication vary according to whether the nerve is irritated or only compressed. Tetanus, spasmodic contraction, hyperæsthesia and intense neuralgia are occasioned by the former; loss of power, wasting, diminution of sensibility, and constant pain until the nerve has undergone degeneration, are met with in the latter. If the compression is only transient, the prognosis is, generally speaking, good, though in a few instances the loss of power has been permanent; if it is continuous, as when the nerve is compressed by callus, atrophy sets in, the fibres disappear, and only a cord is left.

Release of the nerve by chiselling through the callus or sawing off part of the bone has proved successful even in advanced cases; and in some instances, resection of a portion that could not be set free has been performed with the same result. The prognosis depends upon the extent to which degeneration has occurred; if the electric excitability of the parts below is not completely lost, early recovery may be expected, though it may not be perfect for some considerable time.

Injury to joints.—Extension of the fracture into a neighbouring joint is always a grave complication, even when the skin is unbroken. The synovial cavity is filled with blood; it is often difficult to restore the fragments to their proper position, and still more to keep them there; and for fear of the joint becoming stiff, passive motion has to be commenced at a very early period, long before the union is sound enough for use. Moreover, later in life, a joint that has been injured in this way is very liable to be attacked by an obstinate form of osteo-arthritis. When the fracture is compound, the danger is greater still. The cavity that is opened up is often of very great size, and very irregular in shape; and it is lined with a membrane exceedingly prone to absorb any poisonous material that is present. Under these circumstances, it is scarcely surprising that the danger of acute suppurative arthritis is so great.

Dislocation is occasionally, but very rarely, associated with fracture, the bone being forced from its socket, and then broken by a continuance of the same force. No pains should be spared to effect reduction. The patient must be placed under an anæsthetic, the limb secured by means of splints, and the displaced part of the bone, if possible, pushed back. If this does not succeed, either the joint must be laid open and the head of the bone dislodged and restored to its position, or the fracture must be set and another attempt made later when the bone is firmly united.

Inflammation.—Inflammation in the course of a simple fracture is quite exceptional. Sometimes, when the extravasation is very extensive, the hæmatoma slowly suppurates, as it does occasionally in contusions; or inflammation starts from the blebs that form on the surface of the skin; and sometimes a slow chronic form of ostitis sets in afterwards, akin, perhaps, to the arthritis that follows contusions about joints; but this does not occur unless some additional cause is at work.

In compound fractures, on the other hand, if the wound does not heal at once, it often proves a most serious complication. Erysipelas, cellulitis spreading through the deeper planes of areolar tissue, as well as the superficial ones, diffuse suppuration, acute periostitis, osteo-myelitis, septicæmia, pyæmia, hectic, every form of wound disease, in short, may break out in the course of treatment, and either delay recovery indefinitely by the sloughing and necrosis it causes, or itself prove fatal.]

Sloughing.—Sloughing of the skin and cellular tissue may be caused by the violence to which the part is subjected at the moment of the accident; or may occur, as already mentioned, from the pressure of badly-made splints on bony prominences. In the former case, the fracture is almost certain to become compound if it was not so already; in the latter, the slough often bears no relation to the seat of injury, and, so long as it is limited, may be treated as an ordinary bed-sore. All pressure must be removed, so far as is consistent with safety; the position of the limb must be adjusted so that the circulation is unimpeded, and putrefaction prevented. If the cause is removed and no fresh irritant allowed to appear, the sore that is left soon granulates up.

Gangrene.—Traumatic gangrene may be local or spreading. In the former case it may arise from the actual crushing, even when the fracture is a simple one, or from thrombosis, rupture of the main vessels, or tight bandaging; but whatever the reason, if an attempt has been made to save the limb, and it is plainly becoming colder, amputation should be performed at once. The most difficult cases are those which hang in the balance for a day or two, sometimes warmer, sometimes colder, before it is possible to be certain.

Spreading traumatic gangrene may result solely from the defective nutrition of the tissues—the vitality of the part is so low from renal disease, diabetes, cold, exposure, or other causes, that the structures perish even if they are only bruised—or much more frequently from the action of irritants that make their appearance subsequently in the wound. Septic decomposition, high tension and suppuration acting together cause the most fearful form. Putrefaction takes place in the wound; the poisons produced are driven by the tension into the cellular interspaces, destroying everything they touch, and the micro-organisms of suppuration complete the destruction. Hospital gangrene, which was the worst form ever known, was simply the product of these agents acting under peculiarly favourable conditions.

Solid œdema.—Solid œdema, due to lymphatic and venous obstruction, is often present after fractures, especially compound ones in which there has been inflammation or sloughing of the cellular tissue. The nutrition of the whole limb suffers; it remains cold and hard; the skin is tightly bound down to the parts beneath; ulcers are liable to form, and though they may be cured by attention to position and rest in bed, they invariably break out again as soon as the limb is used. In one case I removed a leg, at the patient's request, seven years after a severe compound fracture in which resection had been performed: the ulcer, which was exceedingly painful, had broken out nine times, and he had spent more than four years of the seven in bed.

Muscular atrophy.—Muscular atrophy is present in most cases of fracture. If it is merely the result of inactivity, recovery is generally speaking rapid and easy; but sometimes, when the limb has been severely crushed, or when there has been much inflammation, the fibres are so matted together, and the tendons so crippled by adhesions, that the process is very tedious. In other cases there are special reasons for it: the lower part of the vastus internus, for example, never quite regains its size after fracture of the patella. According to Volkmann, paralysis and contracture are sometimes caused by the prolonged constriction of the blood-vessels: the muscles become stiff and hard; all control over them is lost; and movement becomes intensely painful. It is said that this is due to the breaking up of the contractile substance in consequence of the deficient supply of blood. In other cases again, shortening, sometimes of a very obstinate description, is brought on through malposition during treatment.

Ankylosis.—Stiffness of the joints is very common even when they have escaped direct injury. Bonnet and others have described very extensive alterations as taking place in them merely from prolonged rest, the cartilage disappearing, and the opposing surfaces becoming united by dense fibrous tissue. Such changes, however, occurring independently of inflammation, are very rare. As a rule the joint becomes stiff because passive motion is not resorted to sufficiently early; the capsule becomes rigid; the amount of synovia is deficient; the soft tissues around grow hard and thick; and the folds and fringes become adherent to each other, and no longer accommodate themselves to the changes in pressure as the bones are moved. The tissues in short are so badly nourished that they are unable to do their share of work.

Residual abscesses occasionally make their appearance in compound fractures many years after the original accident, and sometimes minute sequestra are found inside them: in some cases, perhaps, they are small fragments that have been locked in during the process of repair. Atrophy of the bone has also been known to follow without apparent reason, and cases of malignant disease starting from the seat of the injury are not so uncommon as might be expected.

Treatment (Immediate)

In every case of fracture the first thing is to prevent further injury. The limb must be placed in a suitable position; the clothes removed, always beginning with the sound side, and where it is necessary, slitting up the seams; and the injured part thoroughly exposed. A small wound is better sealed at once; dried blood-clot is an excellent protection; if it is large, means must be taken to check the hæmorrhage before anything else. Then the limb must be secured so that the patient may be moved with the least amount of risk.

In fractures of the upper extremity there is no difficulty; the arm can be bound to the side of the body with one handkerchief, and the hand and wrist supported with another tied round the neck to form a sling. In the case of the leg and thigh, however, some form of splint must be extemporised. It may be made out of almost anything: laths of wood, bundles of straw, rolls of newspaper, umbrellas, or whatever else is to be had at the moment; the only requirement is that it should be sufficiently long and rigid to keep the limb steady in the most comfortable position. A broken leg should be laid on its outer side with the knee and hip flexed; the thigh may either be placed in the same position or the two limbs may be tied together and secured to a splint made out of a broomstick with some clothes round it, long enough to reach from the armpit to below the knee. Only in the case of the spine and pelvis nothing of the kind should be attempted: the patient is merely to be placed perfectly straight in the recumbent position until he can be lifted on to a stretcher.

To raise an adult with a broken leg comfortably, at least three persons are necessary: one to take charge of the limb, the others one on each side, facing each other, with their hands well beneath the hips and shoulders; the stretcher should be placed at the patient's head, as it is more easy to lift him over the end. Bearers should be cautioned against keeping step, and if the lower extremity is broken, care must be taken that the shoulders are not raised higher than the feet.

A fracture bed should be narrow, so that the patient may be reached from either side, firm and elastic without being soft, and if the spine or the upper part of the leg is involved, so arranged that nothing is disturbed when the bowels act. Woven wire mattresses with a hair one on the top are the best; sinking at the hip may be prevented by running a fracture-board underneath from side to side. In injuries of the spine, and in any case in an old person, water-cushions under the pelvis are essential. Very many contrivances have been devised for the use of the bed-pan: one of the best is a circular opening in the mattress protected round the edges with oiled silk, immediately under the nates; this is filled up from beneath with a cushion which, when occasion requires, can be lowered by means of a screw attached to the side of the bed and replaced by the pan. Two sheets of course must be used, folded double, one beneath the shoulders, the other at the lower end of the bed, the folded margins meeting over the opening. In other cases a conical wedge of the mattress may be made to slide in and out from the side. Or the opposite plan may be adopted: a very stout piece of canvas, perforated in the centre, is laid over the mattress and fastened all round to a strong wooden frame, a little smaller than the bed itself. When it is not in use, this rests upon the framework of the bed; but it is so contrived that when the pan is required it can be raised with screws or pulleys six inches or so from the mattress with the patient lying on it.

The same precautions must be taken in lifting the patient on to the bed then the clothes must be removed, the skin thoroughly washed and dried all temporary appliances taken away, and the limb either secured with sand-bags or laid upon a pillow lengthwise and tied up in it.

TREATMENT (PERMANENT)

Fractures should in all cases be set as soon as possible, the only exception is when the swelling and tension are already so extreme as to threaten gangrene. If there is the least danger of such a complication, it is better to avoid manipulation, and merely to raise the limb and place it in a comfortable position, secured by sand-bags or tied up in a pillow. In other circumstances there is nothing to be gained by waiting, or by the application of cooling lotions; the difficulty increases every hour; the swelling becomes greater and greater; the muscles, which at first are relaxed, grow more and more rigid; and there is always the risk that by some incautious movement the injury may be made a great deal worse.

1. *Reduction of the fracture*

The first thing is to disengage the fragments and restore them to their proper position. If they are impacted, and it is considered advisable to separate them, a certain amount of force must be used, and where a bone is only partly broken, as in greenstick fractures, it is generally impossible to restore the shape without considerable pressure, sometimes even making the fracture complete; but in all ordinary cases, where the displacement is due either to the weight of the part or to muscular contraction, the less force that is used the better. Gravity must be counterbalanced by arranging the patient so that it assists in the reduction of the deformity, instead of being a source of difficulty, and the muscles must in some way or other be induced to relax.

(*a*) *Anæsthetics.*—In many cases an anæsthetic is essential. The rigidity disappears at once, the limb can be thoroughly examined without causing pain, and if the bone is set immediately, before consciousness is restored, while the muscles are still at rest, the spasmodic contraction does not return. The only objection is that, particularly in men who are accustomed to a large amount of stimulants, and whose struggles are sometimes very violent, the injured limb may be seriously hurt unless it is very firmly held. Where gas and ether are used the risk is not nearly so great.

(*b*) *Tenotomy.*—Tenotomy may be employed when one muscle in particular is in fault. The tendo Achillis, for example, may be divided when there is obstinate spasm of the gastrocnemius, or when the lower end of the femur is detached from the shaft and rotated backwards, so that it is in danger of pressing upon the popliteal artery or vein, but it is seldom required in other cases.

(*c*) *Position.* It is of the utmost importance to place the limb in a position that will secure the maximum degree of muscular relaxation. In Pott's fracture, for instance, the knee is flexed to prevent displacement of the foot by the gastrocnemius; and when the femur is broken immediately below the trochanter, the whole limb is placed upon an inclined plane if the upper fragment is raised to any degree by the ilio-psoas. The opposite muscles are stretched, it is true, but in most of the cases their action upon the fragments is insignificant in comparison, and unless they are irritated by the broken ends and made to contract, they generally yield without trouble.

(*d*) *Extension.*—When the deformity cannot be reduced in this way, extension and counter-extension must be employed, either for the time only, until the limb is secured by a splint, or during the whole period of treatment. In temporary extension one part (generally speaking that nearer the trunk) is held by an assistant, the other is grasped by the surgeon, and steady traction made in the axis of the limb until the fragments are unlocked and the length and shape restored. Often it is necessary to sway the part gently from side to side, or to rotate it a little so as to disengage the ends, and sometimes it is better for the extension to be made by the assistant, while the surgeon manipulates the part himself; in any case the pull must be absolutely steady and continuous, without violent movement or jerking of any kind. When a sufficiently good hold can be obtained, the grasp should be made on the ends of the fractured bone, and the interposition of a joint avoided; the soft parts are not so liable to be injured, but the rule is not absolute. In fractures of the femur, for example, extension must be made from the leg and counter-extension from the pelvis; and when the leg is broken it is very much better to use a slight degree of extension with the knee flexed (so as to relax the muscles of the calf) than to pull it into position by main force.

The amount of force used and the extent to which manipulation is carried must be left to the discretion of the surgeon. In some cases the fragments are too firmly impacted to be separated; in others a splinter is so far displaced from its normal situation that it cannot be restored; or again, the sharp pointed ends have been pushed so far into the soft parts by the contraction of the muscles, that it is impossible to disengage them and bring them into apposition. So long as the fracture is a simple one, it is better to leave these alone, in spite of the prospect of deformity, and the possibility in the last-mentioned case of failure of union, than to run the risk of inflicting even greater injury on the patient. If the fracture is already compound the question, of course, is entirely different.

Continuous extension is required for those cases in which the displacement is maintained by muscular contraction, as in fractures of the thigh. If the femur is broken obliquely, especially in an adult, it is only possible to restore the limb to its normal length by placing the patient under an anæsthetic or tiring the muscles out. Extension for a time only is of little or no use, but if it is kept up steadily and continuously, even though the force is only slight, the contraction gradually gives way, and the limb regains, or nearly regains, its normal length.

2. *Prevention of return of displacement*

As soon as the deformity is rectified and broken ends adjusted, the part must be secured against displacement a second time. The same forces are still acting; however quiet the patient may lie, it is impossible to avoid involuntary movements, the influence of gravity is always at work, tending to displace one fragment from another, and even when there is no spasmodic contraction, the muscles cannot help growing shorter and shorter when the rigid framework is once broken.

The means used to prevent this depend chiefly upon the degree and nature of the deformity. In fractures of the bones of the face, for example (the lower jaw excepted), the tendency to displacement is so slight that, if the fragments can be restored to their proper situation, little more than protection is required; and where one bone in a series has given way, a rib, for instance, or one of the metacarpals, a bandage is, generally speaking, sufficient. Even if there is only a pair, as in the leg, the uninjured one nearly always prevents any serious degree of displacement. On the other hand, in fracture of the bones of the extremities, where the muscles are very powerful and the deformity often exceedingly difficult to rectify, it is rarely possible to keep the broken ends in apposition without the aid of bandages and splints.

Bandages.—Roller and triangular bandages are the ones in common use, though many other varieties are employed in special cases. The former answer best where firm and continued pressure is required, and are made of unbleached calico torn in strips, from four to six yards long, and two to four inches wide, or of flannel, domette, or other loosely woven material, according to the nature of the case and the amount of yielding desired. The latter are most easily made from a square yard of calico cut in two diagonally, and are chiefly of use for retaining dressings in position, and as slings for the support of the arm or hand.

Splints.—Splints may be made of almost anything, but invariably the simpler they are the better. Their object is to keep the broken ends in thorough apposition and at perfect rest; they must therefore fit the limb accurately; they must be well padded, so that the pressure is uniform and does not fall too heavily on the bony prominences or the injured part; they must, as far as possible, fix the neighbouring joints; they must be arranged so that, at any rate at first, the seat of fracture can be easily examined, and they must not interfere with the circulation. Bandages or webbing straps and buckles are used to secure them round the limb. No constricting band should ever be applied directly to the limb beneath. The circulation is already impeded by the swelling and extravasation; the veins are compressed more than the arteries, owing to the thinness of their walls; blood continues to pour into the part without being able to return, and if there is an unyielding bandage round the limb, strangulation and gangrene are very likely to follow. For the same reason, when a single flat splint is used, however well it is padded, it should never be secured to a fractured limb with strapping. Below the seat of injury there is not the same objection. When the humerus is broken, for example, a bandage may be applied with advantage to the hand and forearm, to prevent the passive œdema and swelling that are caused by the obstruction; but even then it is advisable to leave the tips of the fingers exposed, so that there may be no doubt as to the condition of the circulation.

Ordinary pads are much too hard, especially when made with tow; they ought to be sufficiently soft to press evenly on all the surface of a limb, and not harshly on any part. Absorbent cotton-wool folded in sheets answers best.

Movable splints.—The simplest splints are made from soft light wood, generally deal, as it can be worked easily. If they are flat they should be a little wider than the limb, to take off the pressure, but it is more comfortable to have them hollowed out, especially opposite bony projections, and bevelled at the edges. Others are of metal, sometimes perforated on account of the weight. They may be trough-shaped, rigid, and provided with hinges to allow a limited range of movement, or made of some flexible material, such as zinc, or woven wire, so as to fit into all the curves of the part. Where strength is not of importance, as in the upper limb and in the case of children, lighter materials are used, pasteboard, gutta-percha, or what is much better, as it is porous and weighs less, felt steeped in resin, so that it becomes hard when cool. The two last are especially useful, as by warming they can be readily moulded to fit any part; and felt splints can be obtained in sizes, roughly shaped already, so that a very slight degree of modelling is required.

Immovable splints.—Other kinds are made by surrounding the limb with a woven material such as muslin, calico, or flannel, and saturating this with substances which set or become hard when they dry. Starch paste was one of the first employed. The limb is enclosed in a thick layer of cotton-wool, over this are placed longitudinal strips of torn pasteboard soaked in starch, so close together that only a small space is left between, and these are bound together with layer after layer of bandages saturated with the paste, as many as may be required. Sometimes strips of tin are inserted opposite the joints to give additional rigidity. Then the limb is fixed on a splint until the starch is dry. In this way a firm and even casing is obtained, but the process of hardening is very tedious even when the temperature is maintained; the outer layers dry first and prevent evaporation from those beneath, so that where special thickness is required it may be some days before the splint is thoroughly firm.

Plaster-of-Paris is free from this objection. The ordinary bandages are made of a coarse crinoline muslin, and may be kept in a tin case ready for use. The powder is rubbed into their meshes while they are being rolled, and they only require to be placed upright in water for a minute or two, until the bubbles of air have escaped. A flannel bandage is put on first; cotton-wool does not answer so well, as it is very difficult to keep it sufficiently smooth; and then the prepared bandages are rolled round the limb without employing any pressure or making any reverses. Generally speaking, two layers are enough, some loose powder being rubbed in between them, and a little more, with plenty of water, over the surface of the last. Strips of tin may be employed as with starch, and, especially for children, the splint may be made waterproof with paraffin. The setting of the plaster can be delayed by adding mucilage or borax to the water, and accelerated to some extent by alum; but if there is any doubt as to the freshness of the powder it should be rebaked.

For many purposes plaster splints can be made more conveniently with absorbent cotton-wool, as recommended by Gamgee. The limb must be first invested with a sheet of wool, and then strips of the same material, cut to shape, are dipped in plaster and water, the consistence of cream (made by sprinkling the powder into a basin of water, stirring all the while), and fastened round with absorbent bandages. As soon as it is set, these are cut, and the shells lined with the first layer fall apart from the limb.

Gum and chalk—powdered chalk rubbed down with mucilage, until it is the consistence of thick gruel—answers better in some cases. It does not dry so quickly it is true, but it is lighter, firmer, less apt to crack and crumble at the edges, and is more elastic. A flannel bandage is applied first, then an ordinary calico one into which the mixture is well rubbed; a second is placed over this, the whole is given a final coating, and it is then left to dry.

Silicate of soda, of the consistence of syrup, is applied in the same way; but it is better to roll the bandages in the solution, and keep them in it until required. It dries rather more quickly.

Tripolith differs very little in its uses from ordinary plaster. It has the advantage of being rather lighter, and of not softening to the same extent if moistened after it has once set. It is said too, to set more rapidly; but this depends a great deal upon the amount of water with which it is mixed.

Paraffin is rarely employed. The most convenient method is to steep long strips of cotton-wool in the melted fluid, in the same way as with plaster cream, and when sufficiently cool to mould them to the limb. They must then be fixed with a bandage and allowed to harden. A very exact cast of the part may be taken in this way, but it is not so rigid as plaster or gum and chalk, and unless the paraffin is one that only melts at a high temperature, it is liable to become soft from the heat of the body.

Care must be taken to keep the limb well raised while these splints are drying, as most of them contract a little during the process; and the extremities must always be left exposed, in order to judge the condition of the circulation. If the fingers or toes look blue, or become cold and numbed, or if the blood does not return immediately when driven from the matrix of of a nail by a little pressure, the splint must be cut up and removed at once. In recent injuries watchfulness is even more imperative; swelling sometimes sets in very rapidly, and if the constriction is not relieved, the circulation may be stopped altogether, and strangulation and gangrene be caused in a few hours.

After they have been on some time the opposite result generally happens, and the splints become too loose from absorption of the extravasation and wasting of the muscles.

Movable v. *immovable.*—There is no doubt that splints made in this way are admirably suited to fractures that have already united in part; the question is whether it is wise to apply them while the injury is recent, before the swelling has subsided and the danger of inflammation is past. When well made they fit to perfection; they do not require to be readjusted as often as other splints; movement or displacement is hardly possible; the uniform pressure checks muscular spasm and lessens the tendency to swelling and œdema; the patient is able to get about earlier than he otherwise would; and the risk of bed-sores and pneumonia is avoided. In short, they answer every requisite of a splint but one; they do not allow the seat of injury to be inspected; the whole limb is surrounded so that if anything were to happen gangrene might occur before it was found out, especially as in such cases pain is sometimes conspicuously absent.

This danger is lessened by using a thick layer of cotton-wool instead of a flannel bandage, so that the pressure is uniform and elastic; but it can be prevented entirely by making the splint in such a way that it can be loosened or removed at a moment's notice. It may be either cut down one side and fastened with a lace or bandage; or, better, made in two halves.

Modified in this way, a fixed apparatus may be adopted in many cases from the first; only of course care must be used in the selection and they must be well watched. The advantages are immense: reduction is immediate; there is no spasmodic contraction; the extravasation is kept within bounds; blebs cannot form and a check is placed upon the inflammatory swelling. But the pads must fit accurately and be thick enough; the pressure must be soft and perfectly uniform; and the case must be made in at least two pieces, so that it can be removed easily and at once if there is any fear of congestion or any need for readjustment.

In fractures of the femur it does not answer, except in the transverse ones of infants and children. Longitudinal displacement is too easy, and the bony points are not sufficiently marked. These must be left three or four weeks, until there is a certain amount of consolidation and the tendency to shortening is lessened. In the leg, it is more suitable so far as the limb is concerned; the foot and the knee can be easily secured, while the hip cannot; the bone is not so thickly covered, and the muscular contraction is more easily controlled; but the question does not rest on this altogether. The condition of the skin, and the extent to which the soft parts are injured, are more important. If the fracture is comminuted, and some time has passed since the accident so that already there is a great deal of extravasation; if a big vessel has given way; if the skin and the subjacent tissues are badly bruised, and it is doubtful if they can live; or if there is any danger of the fracture becoming compound, it is better to take the leg entirely out of the patient's control, by means of a swing and the ordinary back and side splints. With such an injury, confinement to bed for several weeks is absolutely necessary, whatever appliance the patient wears. It is not necessary to sacrifice the benefits of uniform compression over the whole surface; the blebs, which often form the starting-point for inflammation, and are never found under splints, but always at their edges, can be prevented equally well by using a sufficient amount of absorbent cotton-wool in addition to and between the splints; but these must be arranged so that it is possible to examine the injured part as often as may be wished, without disturbing one of them or relaxing the grasp on the limb.

In other cases, when, for example, the bone is broken transversely and there is not much displacement, when only one of a pair has given way, and when the structures around are but little hurt, this plan should be adopted from the first.

TREATMENT OF FRACTURES THAT ARE COMPOUND BY INDIRECT VIOLENCE

The treatment of compound fractures is guided by the nature and extent of the injury inflicted on the surrounding structures. When the skin is merely punctured from beneath by the sharp end of a broken bone, no plan is more successful than that advocated by Astley Cooper. If the opening is already closed by a clot, every effort must be made to preserve it; but if blood is still oozing out, or if the wound is unavoidably reopened by the manipulation necessary to reduce the fracture the skin around is to be thoroughly cleansed with antiseptics (corrosive sublimate 1 in 500, or carbolic acid 1 in 20); the edges carefully adjusted, iodoform powder dusted in and then a soft absorbent pad of wood-wool or prepared moss laid over it. Sometimes, especially in the leg, the bone is still protruding, tightly grasped by the skin; and occasionally there is some little difficulty in reducing it, even when the patient is under an anæsthetic. The opening may then be slightly enlarged and a further attempt made; if this is unsuccessful, particularly if it is a long pointed spine that is likely to give trouble afterwards, or if the periosteum has been stripped back from it, it is better to cut it off at once with bone forceps. The wound should then be thoroughly washed out and treated in the same way. Even if there is comminution, or if the fracture extends into a neighbouring joint, this plan in actual practice gives results that have not been surpassed.

In all compound fractures, except in the case of the smallest bones, the patient should be confined to bed until it can be seen what course events are likely to take. If the wound is only a puncture, a fixed apparatus may be applied at once; but the splint must be arranged so that the dressing can be easily removed. Either a window must be cut, or what is better, an opening left while the splint is being applied; and to prevent the tissues becoming œdematous and projecting outwards through this, a small but firm pad should be fitted into it. If the temperature rises, the dressing must be removed at once.

In all other cases interrupted splints are used, the pads being covered with oiled silk, and so arranged as to interfere with drainage as little as possible. Fixed apparatus should be reserved until the bones are beginning to unite and any wound that is present has healed.

TREATMENT OF FRACTURES THAT ARE COMPOUND BY DIRECT VIOLENCE

In fractures by direct violence where the soft parts are crushed, the bone perhaps comminuted, and the skin torn and lacerated, the question is different.

The first thing to decide is whether the injury is consistent with life. In many cases, such as railway accidents in which both thighs have been crushed, the shock is so great that the patient never rallies, and any attempt at operating merely precipitates the end; or other injuries of an even more serious description are inflicted at the same time. In such as these, all that can be done is to prevent hæmorrhage (even capillary oozing is serious) and check the tendency to putrefaction which is particularly prone to occur in the region of the bone. Arteries rarely bleed under these conditions, but if they do, or the veins, they should be tied or clamped; then the wound must be thoroughly washed out with a solution of corrosive sublimate as hot as can be borne, and wrapped in an absorbent dressing. Loose clots may be allowed to float away; others should be left untouched. Hæmorrhage from the bone, which is often very persistent, must be stopped by elevation, or pressure.

Meanwhile, every effort must be made to tide the patient over the shock: the blankets must be warmed; hot bottles placed all round the body; the limbs bandaged; and stimulants, brandy and ammonia, administered freely, or even injected under the skin. If reaction definitely sets in, and the temperature begins to rise, it becomes a question whether amputation should be performed at once, or an attempt made to save the limb.

1. *Amputation*

(*a*) *The patient.*—The age and constitution of the patient are the first things to be considered. In children, much more may be attempted than in adults; their tissues heal more readily and they have no anxieties; but in sound old age the power of recovery is often surprisingly good. The condition of the viscera, particularly of the kidneys, is of greater importance. Sloughing and diffuse inflammation are almost sure to occur if the urine is albuminous or the specific gravity persistently low. The vitality of the tissues, if they are crushed or bruised, is too feeble to resist, and the only chance of life lies in the complete removal of all the damaged part. Even when no change in the secreting power of the kidneys can be directly proved, it is distinctly unfavourable if the aspect of the patient is such as to suggest over-indulgence either in food or drink.

(*b*) *The injury.*—The locality of the injury and the complications that are present, as a rule, are final.

The upper extremity.—In the hand and forearm the part must be almost disorganised to justify amputation. The wrist-joint may be opened, the carpal bones crushed and the hand cut to pieces, without such an extreme measure being necessary, if only a single movable finger is likely to be left. I have known such injuries as this treated with corrosive sublimate baths for an hour each day recover without a single febrile symptom. If, however, the large nerve-trunks are injured beyond repair; or if the skin is torn off round the whole circumference for even a short distance, the limb never recovers so as to be of any use. In the former case it remains cold and helpless, often ulcerated or the seat of severe pain; in the latter, it swells up to such a size from solid œdema and becomes so hard and stiff that it is merely a useless log.

The extent of the injury to the soft parts is equally decisive in the case of the arm or elbow. The artery may be wounded, the joint laid open, and the ends of the bone badly comminuted, and yet the vessel may be tied, the fragments of bone removed, and an informal kind of excision performed with an excellent result, so far as utility is concerned, if only the surrounding structures are not too badly bruised. Unhappily such accidents generally occur from direct violence, and then the skin is stripped up, the muscles are torn and bruised, and everything is crushed to such an extent that no alternative is possible.

The lower extremity.—Amputation is more frequently required in compound fractures of the lower limb. The circulation is not so active as it is in the upper, repair is not carried on with the same degree of energy, there is a greater risk of gangrene and of diffuse inflammation, the joints are larger and more complex, and the need for stability is much greater.

In the case of the foot, for example, everything must be sacrificed to gain a firm support. In the hand it is a rule never to remove anything that can by any possibility recover; a fragment of a thumb is infinitely more useful than an artificial one; in the foot free removal is often the better plan. Yet even here much may be done sometimes by judicious conservatism. In a case under my care, in which the contents of a gun had passed completely through the foot, so that an opening was left into which three fingers could have been placed, recovery was so perfect that the patient could walk three or four miles without inconvenience six months after the accident. The bases of the first two metatarsal bones with the corresponding portions of the internal and middle cuneiform were blown completely away; but the external plantar artery in all probability remained intact and the tread of the sole was uninjured.

When there is a compound fracture of the leg the question is generally decided by the condition of the soft parts, especially the skin and the blood-vessels. The ankle-joint may be opened and the bones comminuted, but so long as the circulation is good, and the skin is not destroyed, a very useful limb may be obtained by resecting the broken ends and removing splinters that are loosened too much to live. Similar injuries in the case of the knee-joint are much more serious; compound fractures of the patella only may be treated in this way with a fair prospect of success, even though the cavity of the joint is widely opened; but when the lower end of the femur, or the upper end of the tibia is badly comminuted, the injury is, generally speaking, too severe. Even here, however, primary resection has been performed with success in the case of gunshot wounds.

Compound fractures of the femur are still more serious. If they are caused by direct violence the injury is almost hopeless so far as the limb is concerned. Very often it is much worse than at first sight it appears to be: the muscles are torn and crushed so that they protrude from their sheaths; the deep planes of areolar tissue are laid open, and the skin stripped up from the fascia beneath and bruised beyond recovery for a distance above the seat of injury almost equal to the diameter of the part.

When the injury involves the upper part of the thigh or the hip-joint, the shock is nearly always fatal; and even if the patient rallies it is very questionable whether primary amputation in the upper third or disarticulation should be performed. It is true that there are a few successful cases on record; but certainly in gunshot wounds, if the head of the bone is shattered, better results are obtained by removing the fragments, securing perfect drainage, and amputating later, when the period of acute suppuration is past. Probably in the majority of those instances in which the patient does rally sufficiently, the best chance lies in merely removing the part that is injured, (for which Paquelin's cautery is of excellent service), leaving the wound open, and, by means of antiseptics and drainage, limiting the amount of septic absorption as much as possible. Even in other parts of the body this plan may sometimes be followed with advantage; it is true there is usually a large amount of suppuration, but the shock is not nearly so great as when a formal amputation is performed, and owing to the nature of the wound the amount of septic absorption is much less than might be expected.

2. *Preservation*

If it is determined to try and save the part the fracture must be reduced and the same general principles of treatment followed, interrupted splints and pads covered with oiled silk being used. The presence of a wound, however, and of more or less serious injury to the other structures in the limb—muscles, arteries, cellular tissue, &c.—necessitates something more.

Hæmorrhage must be checked at once. The limb must be raised, all constriction removed, the main artery, if necessary, placed under control, all loose clots washed away, and any bleeding point secured. General oozing is checked by washing out the wound with an antiseptic solution (tincture of iodine or corrosive sublimate) as hot as can be borne, and applying gentle pressure afterwards.

Splinters that are quite loose and detached should be removed, and if the ends of the bone cannot be readjusted, especially if they are stripped of their periosteum, they may be resected. Large fragments that are firmly adherent should be left. An exception may be made in the case of gunshot wounds caused by projectiles of high velocity; in these it has recently been shown that, if a commencement is once made, it is very difficult to stop; removing one fragment seems to loosen all the rest, so that if the drainage is good it is better to leave them until a certain amount of consolidation has taken place. If much is removed care must be taken to bring the broken ends well together, or union may fail.

The wound must be thoroughly cleansed so that no poisonous material can form, and thoroughly drained, so that if it does it may escape externally and not be absorbed. The principles on which this is to be done are easily laid down; the details vary naturally with each case.

The skin for some distance around must be cleansed with turpentine and a strong solution (1 in 500) of corrosive sublimate. All dirt must be picked out; if it is so much ground in that it is impossible, the tissue should be cut away, unless it is skin. The dirt is always on the outside of this, and it can be rendered inert without destroying the whole thickness and endangering cicatrisation.

If the wound is foul, or such that it cannot be sealed at once, it must be cleared of all foreign matter and blood-clot, and washed out with an antiseptic, using a rubber drainage-tube or a catheter to conduct the fluid into all the recesses. At the same time, care must be taken to make the opening sufficiently free, and if necessary to make others, so that the fluid is not retained and absorbed. Immediately after an injury of this kind, when the planes of fascia are torn across at different levels, and all the lymphatic spaces are gaping widely, a poisonous amount can easily get into the circulation, and either cause local sloughing or lead to constitutional symptoms.

Tincture of iodine (1 in 80), carbolic acid (1 in 40), or corrosive sublimate (1 in 1,000), are the most used; the last is the most effectual, but at the same time the most dangerous, if retained. If there is any capillary oozing they should be injected at a temperature of 120 to 140° F., so as to leave the wound thoroughly dry; it is of great importance to reduce the amount of discharge as much as possible, and keep the cavity free from any putrescible matter. With this object Gamgee recommended equal parts of spirit and water, or a saturated solution of borax with about one-eighth of its bulk of glycerine, in preference to the watery solution of any antiseptic.

After this iodoform may be dusted lightly over the surface. It is true that grave doubt has been thrown on its merits as a germicide, and that in some instances, when too much has been used or the patient has been peculiarly susceptible, serious symptoms have followed its employment, but there can be no question that in some way it possesses the power of limiting the amount of exudation and discouraging decomposition.

As soon as everything is satisfactory the deeper parts must be brought into the best apposition possible, buried sutures of catgut being used, if necessary, both in the bones themselves and in the dense sheets of fascia. If the wound were a simple incised one this would be enough, but it is always irregular in shape; the tissues are badly bruised and crushed, not cut, and the necessary cleansing and the antiseptics injure them still more. As a result, a large amount of fluid is sure to collect; absorption, even when aided by pressure, cannot keep pace with exudation, and unless free exit is provided tension and inflammation must follow. If there is a dependent opening, perfectly straight and wide, it may be left, with an absorbent dressing properly arranged (that is to say, a piece of protective first, as large as the wound), and all the fluid will be sucked out; but such a condition is rare in a compound fracture. Almost always the internal wound is very large, and the external very small, and at the top, or at least very rarely at the bottom.

Under these circumstances counter-openings must be made wherever there is the least indication (and advantage may be taken of these to get rid of as much of the extravasated blood as possible), drainage-tubes of sufficient size must be inserted, and the edges of the skin wound must be left widely open, sutures only being used to retain torn flaps in position.

All the points at which fluid can exude should be covered with waterproof or protective to prevent the dressing sticking to the sarface and becoming clogged. The more absorbent the material used to envelope the part the better. Wood-wool and prepared moss are some of the best; Lister's gauze, owing in a measure to the resinous substance with which it is impregnated, takes up too little, and absorbent cotton-wool by itself is apt to cake if there is much discharge. Decomposition of the exudation can hardly take place in the dressings, owing to its concentration, and it may be rendered impossible by having the material prepared with some non-volatile antiseptic.

If this has been successful the dressing may be left untouched for two or three weeks. Drainage-tubes, however, cannot remain so long; as a rule they must be removed by the third day, as they are very liable to become plugged with coagula and rendered useless. After this the longer the second dressing is postponed the better; every time the fracture is touched it gives pain, causes irritation, and delays repair. The wound, if the treatment is carried out thoroughly, and the patient's tissues are fairly sound, fills up from the bottom, and when at length it is exposed it is either already skinned over, or else is level with the surrounding surface, perfectly smooth, pale, and perhaps just moistened by a trace of pus.

Inflammation, the result of continued irritation (whether by tension, want of rest, foreign substances, or decomposition), has been successfully prevented.

In many cases, especially where the foot and hand are concerned, or where a joint is involved, or where from any other cause the prospect of limiting the amount of exudation is doubtful, the whole part may be immersed in a bath. Sometimes, when a hand is crushed, it is impossible to tell what will live and what will not; more than is necessary may be cut away, or, on the other hand, some part that is already dead and beginning to slough may be left. Such cases may be placed in a warm bath of corrosive sublimate, and left with perfect safety, always provided the whole cavity of the wound is laid open. If this is not done, putrefaction may still go on in the interior. I have known this happen in a compound dislocation of the wrist; a large cavity filled with extravasated blood was overlooked under the deep palmar fascia, and putrefaction and suppuration continued unchecked, although the hand was kept in a continuous bath; the fluid never penetrated into it.

If the bath is continuous, one part in ten thousand is sufficient; if it is only used for an hour or two in the course of the day, it should be at least one in a thousand; and a few drops of hydrochloric acid or ammonium chloride should be added. Careful watch must of course be kept upon the patient's teeth, and if there is any diarrhœa, the corrosive sublimate should be stopped at once and boracic acid substituted; but though I have treated many cases in this way I have never known any serious consequence of this kind result. The limb should be fastened lightly on a splint, the wound left widely open, and, if necessary, counter-openings freely made. There is no decomposition; the dead tissues absorb and retain so much of the antiseptic that they do not become putrid; the sloughs are, it is true, somewhat slow in separating, but when granulations have once formed, recovery is rapid, and the only tissue lost is that which has been killed by injury; none is destroyed by inflammation.

Sometimes, however, in spite of all precautions or because they are adopted too late, the temperature begins to rise, the patient becomes feverish and restless; redness shows itself round the wound, and the limb becomes hot, swollen, and tense. Inflammation has set in.

The treatment of this depends upon the cause. If it is really due to a broken-down constitution; if, as sometimes happens even with simple fractures, the tissues are so badly nourished in consequence of diabetes, renal disease, chronic alcoholism, cold, exposure, and other causes acting together, that the least injury makes them slough, the prognosis is exceedingly grave; operation is hopeless; the dressing must be taken off, the limb raised and kept at an even temperature; all constriction removed, decomposition prevented as far as possible, and the patient's strength husbanded in every way in the hope that the sloughing may cease and a line of demarcation form. Too often it becomes a case of spreading traumatic gangrene; the temperature falls, the face becomes dusky, and the patient sinks into a semi-comatose condition which proves fatal in the course of forty-eight hours.

If, on the other hand, the inflammation is the result of local causes, there is some hope of being able to save the limb.

Free exit must be provided for all discharges; the wound must be thoroughly washed out again; incisions made wherever the skin is tense and œdematous, especially on the inner side and where the tissues are saturated with extravasated blood; and large drainage-tubes inserted, as the secretion is sure to be profuse. It is no use waiting for the boggy sensation of impending suppuration. If the inflammation is acute, the continuous application of cold, though it is not so comfortable at first, is better than warmth. An ice-bag should be laid along the course of the main artery (ligature of the femoral has been performed to check acute suppuration in the knee-joint); and a number of drip pots containing spirit and lead lotion arranged over the injured part, so that there may be constant evaporation from the surface. Any degree of cold that is desired may be obtained in this way; the vessels become so constricted and the amount of blood flowing through the limb so reduced, that the exudation comes to an end and the inflammation cannot spread. Care indeed must be taken not to carry the proceeding too far ; I have known a limb cooled down to such a degree that there was some fear of gangrene.

Meanwhile, the constitutional treatment requires no less attention. It very rarely happens that the patients in whom this complication occurs are such as would stand depletion or blood-letting. Much more frequently they are utterly broken-down in health, often on the verge of delirium, and quite incapable of taking the requisite amount of nourishment. Stimulants generally have to be administered freely—brandy in ordinary cases, bottled stout if there is any sign of delirium tremens ; pain and sleeplessness must be controlled by sedatives ; opium is by far the most useful, but great care must be taken in its administration, as many of these patients are already the subjects of advanced renal disease ; the bowels must be kept open and quinine given freely, if the temperature is high or if rigors set in. Everything depends upon maintaining the patient's strength until further absorption of the poison can be checked by energetic local treatment.

Secondary amputation.—If it can possibly be avoided, amputation should not be performed at this stage. If the attempt to save the limb has failed, and the time before the inflammation commenced has been lost, it is best, if it can be done, to wait until the fall of the temperature in the morning shows that the tissues are getting the better of the contest and are forming a line of demarcation. Then the operation is very successful, and it often happens that a patient who appears to be dying from exhaustion and fever sleeps well the following night, and recovers from that moment. Sometimes, however, it must be done at once ; it gives the only chance of saving a life threatened by absorption from an inflamed and partly gangrenous limb. The condition may appear to be desperate, but the free removal of the whole source of the poison is the only thing left, and occasionally, even when the flaps are sodden and œdematous, and the pulse too quick to be counted, it meets with surprising success.

COMPOUND FRACTURES INTO JOINTS

The treatment must be carried out on exactly the same plan, only it must be remembered that now, no matter how small the wound of the skin may be, its real extent corresponds to the size of the synovial membrane. If there is only a puncture (such as is sometimes produced by a splinter of bone), and the opening does not appear direct, or if it is merely a clean incision, an attempt may be made to close the wound as already described, and prevent inflammation by cold, elevation, rest, and every other means that may be available ; but careful watch must be kept upon the condition of the joint and the temperature of the patient, so that suppuration may not set in unawares. If it does, the only hope lies in free incision and thorough drainage. In all other cases, especially where the force is direct and the skin perhaps torn or ground in with dirt, it is better to enlarge the wound at once, wash out the joint thoroughly with corrosive sublimate solution (or immerse the part bodily in a bath), and make counter-openings for drainage wherever there is a chance of any pocket forming. The question as to the advisability of excision or amputation must be determined in each case, partly by the constitution of the patient, partly by the amount of injury ; if the bone is extensively comminuted, but the skin fairly sound, and the circulation not seriously interfered with, primary excision may be attended with the greatest success, even in the largest joints; under other circumstances (except in the case of the hip) amputation affords the only chance.

Other complications that occur in the course of treatment of fractures must be dealt with by themselves. Injuries to important viscera, such as the lungs, require special consideration; cellulitis, erysipelas, pyæmia and other forms of diffuse inflammation are described elsewhere. Abscesses may have to be opened and sequestra removed years after the original accident; passive motion and the breaking-down of adhesions are often required before it is possible to make use of the joints or tendons; massage and galvanism may be needed to restore strength to the muscles; friction and bandaging may be necessary to relieve the obstinate œdema that sometimes follows, and to prevent ulceration; and even amputation may be required after all: either the limb is useless and the seat of constant pain, or there is such an amount of suppuration that the patient is in danger of sinking from hectic and exhaustion.

FRACTURE OF THE BONES OF THE FACE

The Nasal Bones

The nasal bones often suffer from direct violence; the fracture may be compound, either externally, internally, or both, or it may be comminuted, and the injury may be limited to the bones themselves, or the septum may be bent or crushed in, or the other bones that surround the nasal cavities may be involved as well. I have known the greater part of the cribriform plate of the ethmoid comminuted and removed in splinters through an opening in the nose, so that the dura mater was plainly visible.

Hæmorrhage is always profuse; emphysema is occasionally present from the escape of air into the tissues, and deformity and swelling are generally very considerable. No pains should be spared to effect reduction as early as possible. Manipulation is exceedingly painful, so that, if the displacement is at all extensive, it is advisable to give an anæsthetic. The bleeding, which is sure to be profuse, must be checked afterwards by injecting ice-cold water, or by the application of an ice-bag. Elevation from within, with a steel director or a pair of dressing-forceps, may be tried first, but they are not of much service in really bad cases. In some instances it is necessary to grasp the fragments with smooth-bladed forceps, bent so as not to pinch the soft tissues near the nostril, and twist them into position. Later on, a great deal may be done to correct any deformity that is left by means of pressure. A spring truss may be used, especially at night, outside the face, or, as Erichsen suggests, india-rubber bags may be introduced into the nostril and inflated. Suppuration is not uncommon, but it is rarely serious; ozæna and necrosis, however, occasionally occur, and when the fracture extends on to the face, so as to involve the nasal process of the superior maxilla, stricture of the lachrymal duct generally follows.

Fracture of the Superior Maxilla

The anterior wall of the antrum may be driven in by a blow with the fist, or from a cricket-ball, loosening the teeth, and leaving a serious degree of disfigurement. Hæmorrhage is always profuse, and surgical emphysema may occur, but rarely to any extent. Or the whole bone may be driven in and crushed, and the injury may extend to the other bones of the face, and even to the base of the skull. The deformity in these cases is very often extreme, and in many of them very little can be done to reduce it. The prognosis must always be guarded, as it is not uncommon for serious injuries of this character to be associated with concussion of the brain and fracture of the bones of the skull.

Fracture of the Malar Bone

The zygoma is occasionally broken by direct violence, and it has given way from within. Unless it is driven so far inwards as to interfere with the action of the temporal muscle or the lower jaw, treatment is scarcely necessary.

Fracture of the Lower Jaw

These may be the result of direct or indirect violence. Blows with the fist and kicks are the most common cause, but occasionally they are due to lateral compression. Fracture near the condyles is produced either by a fall upon the chin, or by a blow on the side of the face; in the former case there may be at the same time injury to the external auditory meatus, or to the base of the skull; in the latter it is usually associated with a fissure through the opposite ramus.

Seat of injury.—The most frequent seat of injury is immediately in front of the mental foramen close to the canine tooth, owing to the way in which the bone is hollowed out to form the socket for its fang; but separation may take place at or near the symphysis, and the angle, the neck of the condyle, and even the coronoid process have been known to give way occasionally. Multiple and comminuted fractures are common, and with few exceptions they are compound into the mouth. Teeth are often loosened, and sometimes detached completely.

Symptoms. *Displacement.*—The nature and degree of the displacement depend upon the seat of injury, the obliquity of the fracture, the nature of the force, and the action of the muscles. When it occurs at the angle, and the dense tendinous insertion of the masseter is not torn, it is generally very slight; when the neck is broken, the condyle is pulled almost out of its socket by the external pterygoid, and the rest of the jaw is forced to one side by the action of the other muscles. In the ordinary form, when there is but a single fracture through the horizontal ramus, the longer of the two portions drops to a certain extent, partly from its weight, partly from the action of the muscles attached to the hyoid bone; the shorter may lie to its inner or outer side, according to the obliquity of the fracture, but it is rarely displaced far enough to completely override the other. If the median portion is detached, it is drawn downwards and backwards from between the others, so that these overlap it and approach each other in front. When the bone is comminuted the displacement may be greater still, and detached fragments and loosened teeth may have to be removed before the deformity can be rectified.

Undue mobility and crepitus are nearly always present; impaction very rarely occurs; pain is severe, and is much increased by speaking or by attempts at mastication; the patient indeed often supports his jaw with one hand so as to steady it to a certain extent; and blood escapes freely into the mouth, not only from the bone but from the torn vascular gum, and dribbles away with the saliva. Inflammation, leading to submaxillary suppuration and even necrosis, is very common, and the amount of callus thrown out rarely fails. In many cases the inferior dental artery must be injured, but it is very unusual for it to bleed seriously; and though the accompanying nerve must be torn or stretched in fractures behind the mental foramen, anæsthesia is rarely noticed. It is quite possible that it is usually overlooked until the injury is repaired. Many of the teeth may be loosened, and occasionally some of them are completely detached; these, if they do not interfere with the adjustment of the fracture, should be replaced and carefully protected from pressure; if, however, they are in the line of the fracture itself, they generally have to be removed at a later period.

Treatment. *External appliances.*—When there is only a single fracture and the teeth are fairly sound, the simplest apparatus is sufficient. One webbing strap is placed beneath the jaw, carried upwards on either side over the temporal region, and fastened a little in front of the vertex; and a second is passed horizontally round the forehead and below the occipital protuberance. Where they cross a slit should be cut in the horizontal one to allow the other to pass through, or they should be sewn together, and for additional security they may be connected by a tape over the sagittal suture. Buckles, protected underneath with little wash-leather pads, should be used to secure them. In ordinary cases there is no tendency to displacement forwards; but if, owing to the convexity of the lower margin of the jaw, the vertical band is inclined to slip too far back, it may be secured in position by a tape stitched to it and passed in front of the chin. In comparison with this a four-tailed bandage is untidy and always liable to become loose.

If, owing to the obliquity of the fracture, there is any tendency for the shorter of the two fragments to be displaced inwards, lateral compression must be avoided. A cap may be made from gutta-percha cut into the shape figured, moulded round the chin and lined with wash-leather; but it is, generally speaking, sufficient to stiffen the portion of the strap that lies beneath the jaw by fastening to it a strip of pasteboard, poroplastic felt, or tin covered over with wash-leather. As it is intended to prevent rather than to exert pressure, it should be a little wider than the part of the jaw to which it is fitted, and the ends should be bent up on either side. Gutta-percha is cumbersome, uncomfortable from retaining perspiration, and encourages suppuration, especially if the tissues are bruised (fig. 99).

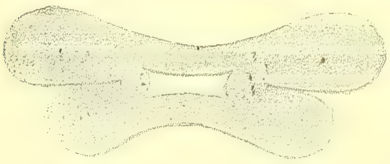
FIG. 99.—Gutta-percha splint for lower jaw.

Interdental splints.—Interdental splints are occasionally required when the teeth are absolutely perfect, in order that the patient may be fed; the space that exists behind the last molar is rarely sufficient for the purpose, and its position is exceedingly inconvenient. In many cases they may be used with great advantage to retain the fragments in position.

The simplest, but one that is very efficient, is made of gutta-percha moulded directly on to the teeth. Two wedge-shaped pieces are used, one for each side, and one of them must be long enough to reach from the last molar to beyond the fracture. The gutta-percha is merely softened, introduced into the mouth, and the teeth of both jaws pressed down into it, while the outer and inner surfaces are smoothed down and moulded as much as possible by the aid of the fingers. A certain amount of shaping is required afterwards; redundant portions have to be cut away, and angles rounded off to avoid pressure, but an excellent splint, holding each fragment firmly on to the upper jaw, is obtained in this way, and abundant room left either at the front or on one of the sides for feeding purposes.

The quieter the part can be kept, the quicker union takes place; talking must be prevented as far as possible, no attempt at mastication may be allowed until the fragments are fairly well united, that is to say, after four or five weeks. All food must be either fluid or semi-fluid, as even movements of the tongue are injurious; and, to avoid the accumulation of decomposing particles, the mouth must be washed out frequently with a weak carbolic or other antiseptic solution, and the teeth cleansed at least once a day with some soft linen.

In a large number of cases, however, owing either to the obliquity of the broken surface or the comminution of the fragments, a more complicated apparatus is required. If the teeth are fairly good and numerous, Hammond's wire splint or an interdental plate of vulcanite is the most satisfactory. In either case it is essential to take a wax mould of the alveolar arch, and from this form a plaster cast. The easiest way is to take each fragment separately, and combine the casts together, so as to get a fair representation of the arch before the accident; but sometimes a mould must be taken of the whole at once, and the cast sawn in two and readjusted afterwards. Whichever plan is adopted, the splint must be formed upon the cast, and must be made to fit it in every detail. Hammond's consists of a stout piece of wire bent into the shape of a horseshoe. The ends are soldered together, and it is twisted and turned until it fits perfectly into every irregularity of the teeth, both on the outside and the inside of the arch. When this framework is allowed to settle down well upon the necks of the teeth, and is secured here and there at convenient distances, with finer wires passing from one bar of the splint to the other between the teeth, movement is scarcely possible (fig. 100).

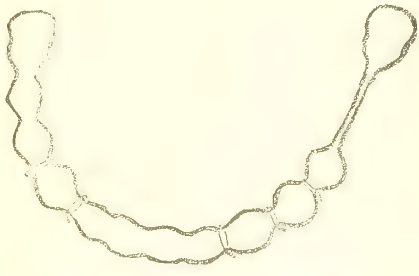
FIG. 100.—Wire splint for fracture of lower jaw.

Vulcanite splints are made to fit upon the crowns so that the teeth sink into deep sockets and interlacing wires are not required; they are equally secure, but the rubber from which they are made requires special skill during the process of manufacture, and they are more cumbersome. Moreover, they cannot so well be trusted without a retaining band outside the face, and particles of food are more likely to collect beneath them and become offensive from decomposition. The same objection holds good with regard to metal plates, which have been employed in a few instances with considerable success.

Wiring.—It must be admitted that in some obstinate cases there is a great temptation to try and secure the fragments by fastening the teeth together with wire or silk, but it rarely succeeds. The process is not nearly so simple as it appears to be; it is very difficult to get the wire sufficiently tight, and even when it is it has very little real hold upon the fragments. But the most serious objection is that it tends to irritate the gums and to loosen and even cut into the substance of the teeth. The plan advocated by Thomas is the least objectionable. A hole is drilled through the alveolar margin of the jaw on one side of the fracture and the ends of a loop of wire passed through this in opposite directions, so that it embraces a tooth belonging to the other fragment. The ends are not fastened together, but merely coiled up on a twister so that they can be tightened as required (fig. 101).

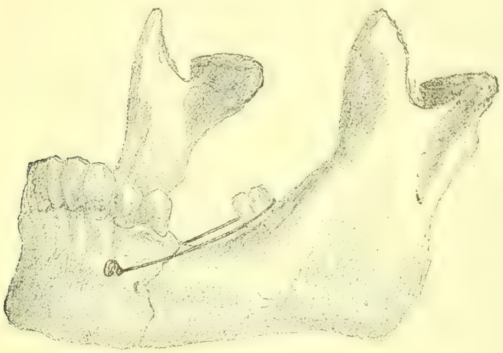
FIG. 101.—Fracture of lower jaw, wired after Thomas's plan.

When however measures of this kind are necessary it seems better at once to drill and wire the fragments themselves. I have adopted this plan on several occasions in which the median part carrying the incisor teeth was completely separated from the rest. There is no difficulty about the operation, especially with the American dentist drill; the wires can be easily passed through and either twisted as Thomas suggests or tied and clamped with shot; and I should not hesitate to adopt it when, from obliquity of the fragments or other causes, it was difficult to retain the ends in position by ordinary measures.

Combined internal and external splints.—Many attempts have been made to fix the broken portions between an interdental plate made of ivory, metal, or vulcanite, and a splint below the jaw. Lonsdale's clamp is made upon this plan, with or without side-pieces to fit along the cheeks, the two splints being connected together by means of a screw outside the mouth. In other cases stout metal bars are fastened to the interdental plate and then curved round the lips at the angles of the mouth and fastened to the under piece. But though these may be of service in exceptional instances, chiefly when the fracture is near the symphysis, it rarely happens that the tissues beneath the jaw remain in a condition fit to stand much pressure during the critical period of the treatment. Nearly always they are too tender and too much swollen, and they very soon become inflamed. Moreover, all these appliances have the serious disadvantage of projecting outside the mouth, so that they are very liable to accidental displacement, especially during sleep.

When the fracture is situated far back the difficulty of retaining accurate adjustment is greater still, and many of these cases tax the ingenuity of the surgeon to the utmost. It has even been necessary to drill and wire together opposite teeth in the upper and lower jaws. Fortunately, however, these cases are not often met with, and it is not uncommon for fractures which at first look perfectly hopeless, so far as adjustment is concerned, to improve gradually as the callus grows firmer, until the position is, comparatively speaking, good.

Complete failure of union is very rare, but it has been known to occur from necrosis and from accidental displacement of teeth. If a false joint is formed and from its position the jaw is disabled, the ends must be exposed, thoroughly refreshed, and wired together. *Complications* during treatment are of common occurrence. The health of the patient sometimes suffers considerably, especially when there is much discharge into the mouth. Abscesses form beneath the jaw and have to be opened and drained. Fragments of bone necrose and must be removed; and the same thing often happens to the teeth when they have been loosened at the time of the accident. One or two cases of permanent paralysis of the inferior dental nerve have been recorded.

FRACTURE OF THE CLAVICLE

Cause.—These are the commonest of all fractures, and more than half take place in children under six years old. Occasionally they are due to direct violence, and then any part of the bone gives way, and the fracture may be transverse, oblique, comminuted, or even compound. Much more often the force is indirect (from a fall out of bed, for example), and the line of separation either runs through the middle of the bone, as in children, or just external to it, where the two curves meet, as in adults. In a few instances the clavicle has been broken, even in men who to all appearance were perfectly healthy, by the sudden arrest of the momentum of the arm; and sometimes it has given way genuinely from muscular contraction, probably of the pectoralis major and deltoid.

The scapula and the upper extremity are held off from the thorax by the clavicle, as by an outrigger, so that the arm may have a wider range of movement and the muscles better leverage; but as a result the whole force of any shock that falls upon the point of the shoulder or upon the outstretched arm is borne by this bone alone; if it is soft, it bends; if firm and hard, as in adults, it breaks at the point of least resistance midway between the two fixed points. Were it not for the peculiarity of its shape and its great elasticity, fractures would be even more common than they are.

Fractures in other parts of the bone are rare, unless they are caused by blows or other direct violence; but they may take place either at the sternal end, in the region of the coraco-clavicular ligaments, or outside them, and I have seen one case in which, so far as could be ascertained at the time, the epiphysis had been detached. In infants many of the cases are merely partial or greenstick fractures; in adults they are usually complete and oblique from above downwards and inwards. Complications are very rare, but occasionally the skin gives way, generally from sloughing over a projecting fragment of bone; and a few cases are on record in which the subclavian vein or artery, the brachial plexus, the pleura, and even the first rib have been injured at the same time.

Displacement.—In greenstick fractures there is merely an elevation about the middle of the bone, projecting upwards and backwards. In complete ones the displacement is in the same direction but more extensive. The inner fragment held by the rhomboid ligament and the costo-coracoid membrane on the one side, and the sternomastoid muscle on the other, is rarely much affected; but sometimes the outer end is raised so that it projects beneath the skin. This may be due to the pressure of the outer fragment on its under surface: the rhomboid ligament varies, however, very much in strength, and I have known it replaced by an arthrodial joint with a small separate synovial membrane. The outer fragment, on the other hand, is drawn inwards by the action of the muscles passing from the thorax to the arm, so that there is a distinct amount of shortening, one fragment slipping beneath the other; it is rotated forwards at its outer end by the serratus magnus and the pectorals until it forms an angle with the true axis of the bone, and it is depressed to some extent by the weight of the arm.

Of these three, the shortening is the most serious and the most difficult to rectify. Depression is often more apparent than real. Owing to the shape of the thorax, the shoulder in the living subject, as soon as it has lost the sole bony support, sinks in towards the middle line of the body, and its outline becomes more sloping, so that it gives the appearance of depression; but though this is often real and very considerable, in many cases it is almost if not altogether absent.

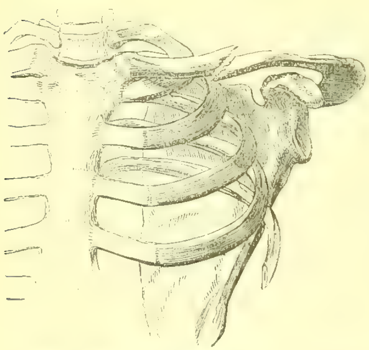

FIG. 102.—Displacement in fracture of the clavicle.

In fractures through other parts of the bone the degree and nature of the deformity are very variable. When it is close to the sternal end the fracture is usually transverse, and the displacement only concerns the outer fragment; if it lies in the region of the coraco-clavicular ligaments there may be none at all: while if the acromial end outside them is broken off, the small portion that is detached may be rotated to such an extent as to be almost at right angles to the rest.

Symptoms.—The ordinary signs of fracture are usually all present, and well marked. The patient stands with his head inclined towards the injured side and supports the elbow with the other hand. The outline of the shoulder is altered; it is more sloping, and the point of it is brought much nearer the middle line of the body. The projection can often be seen at once, or it may be necessary to run the fingers along the bone. Crepitus is present in all but greenstick fractures, and may be elicited by drawing the shoulders backward so that one fragment rubs against the other; but, as a rule, it is scarcely worth while giving the patient so much pain. The same may be said of undue mobility. Fractures through the coraco-clavicular ligaments are an exception, as in them the only signs are localised tenderness and a slight degree of crepitus obtained by direct pressure. The loss of power, not only in greenstick fractures but even when the bone is broken completely in two, is by no means absolute. It is not uncommon to find that the patient is able to place his hand upon the back of his head, if he is sufficiently resolute to stand the pain.

Treatment. *In greenstick fractures.*—There is little or no trouble in the case of the greenstick fractures that are so common in children. The deformity must be rectified as far as possible. It rarely happens that the shape of the bone can be exactly restored; direct pressure is the only means that can be applied, and if the jagged edges of the broken part are so far displaced that they fit against instead of between each other, this is of little service. Generally, however, the angle is merely an exaggeration of the normal curve, and it gradually becomes smoothed down as the child grows older. All that is needed is to confine the arm to the side with a bandage under the clothes, taking care to have the skin thoroughly dried and dusted to avoid excoriations. In every case of fractured clavicle it is as well to have the edges of the bandages sewn together in two or three vertical lines to avoid displacement; strapping should be sparingly used in the case of children. Union occurs very soon, and all bandages may, as a rule, be left off at the end of ten days or a fortnight, though it is as well to keep the arm inside the clothes for a few days longer.

In fractures without displacement nothing more is required than to support the weight of the elbow and forearm and protect the shoulder from any accidental movement. The simplest apparatus during the daytime is the triangular bandage used as a sling. This is made from half a square yard (cut diagonally) of unbleached calico or any other material that is sufficiently strong and unyielding, and is applied so that the two acute angles are tied together round the back of the neck, while the forearm rests in the sling thus made. The long side of the triangle corresponds to the hand; the right angle to the elbow; and the layer that comes up in front of the forearm passes over the neck on the injured side. This leaves the right angle projecting between the arm and the body, and the flap so formed is brought round the elbow and pinned on to the front layer, so as to include the joint in a kind of cap (fig. 103). At night the elbow is secured to the side with a bandage, and the patient is directed to lie on his back, with only a small pillow beneath the head.

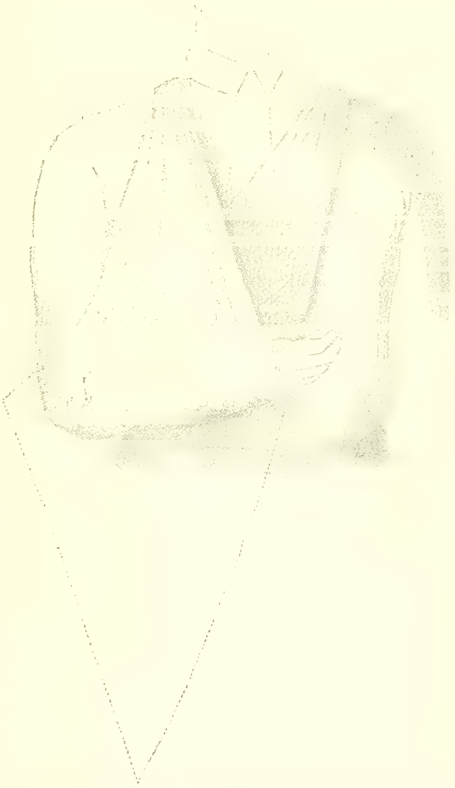

FIG. 103.—The triangular bandage arranged as a sling. The dotted line represents the position before the end is brought over the shoulder of the injured side.

In fractures with displacement.—In adults, if there is the ordinary displacement, shortening is the rule, not the exception, no matter what appliance is used. Fortunately it does not interfere with the utility or strength of the arm; but often it is very unsightly. The method that gives the best result is to keep the patient permanently on his back, in bed, on a well-made hair mattress, with only a small pillow beneath the head; and where, as in ladies, it is essential to avoid deformity, this is the only plan. Even when the position is too irksome to be kept up without intermission for three weeks, the requisite length of time, it is of great service if it can be managed for the first few days. All that is necessary is a bandage to confine the forearm to the front wall of the thorax and a cushion to support the elbow. The angle and vertebral border of the scapula are fixed by the pressure of the body; the point of the shoulder is held back; and the weight of the part, instead of causing downward displacement, assists. All the muscles are relaxed; the amount of shortening is reduced to a minimum, especially if the forearm is brought across the chest; and if the position can only be kept up, union is almost perfect.

The number of appliances that have been suggested and tried in fractures of the clavicle is sufficient proof that no one of them is satisfactory; and complicated ones, even when they can be obtained in time, and have not to be made to fit the patient, are no whit better than, if they are as good as, the simplest. It is impossible to depress the inner fragment if it is tilted upwards; the head may be kept bent to relax the sternomastoid, but that is all. Direct pressure only causes sloughing; and though, according to Sayre's plan, the clavicular part of the pectoralis major may, when the humerus is drawn behind the trunk, possibly tend in some slight degree to pull it downwards, it becomes relaxed again as soon as the arm is fixed in its permanent position.

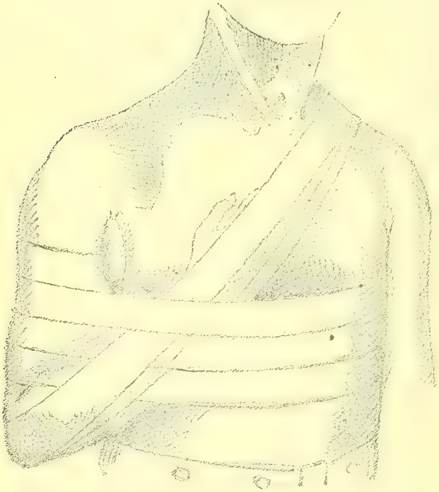

FIG. 104.—Bandage for fracture of clavicle with pad in axilla.

More may be done with the outer fragment. The downward displacement gives no trouble; all are agreed that the elbow must be raised either by means of a sling or by a bandage carried over the opposite shoulder; this, however, is the least serious of the three. Rotation forwards is more difficult, but it may be met in various ways. One plan is to pull the whole arm, including the elbow, back behind the median lateral line of the trunk: if this is done an axillary pad must be used to prevent its being pulled inwards as well, and so making the shortening worse (fig. 104). Another is to bring the elbow so far forward that the hand rests on the wall of the chest, above the opposite breast; and then, by means of a bandage carried under the point of the elbow, attempt to force the shoulder back. This method is also of service in correcting the amount of shortening, as it tends to some extent to drive the shoulder out as well. A third relies on fixing the scapula against the trunk by firmly strapping it down. The shoulder must be held in position; a pad accurately adjusted over the angle and vertebral border; and then fixed by strapping carried obliquely upwards from the sternum towards the backbone. Of these three the first is the one that in actual practice succeeds best; the second, though it is of assistance in correcting shortening, relies too much on force and is very uncomfortable; the third answers exceedingly well in the recumbent position, but if a patient is allowed to get about it is not possible to fix the scapula efficiently.

Shortening is the most difficult of all; indeed, if the fracture is oblique, and the patient is not confined to bed, it is almost impossible to counteract the muscles passing from the thorax to the arm, without using an amount of force that would be unreasonable and injurious. It is true that by placing a pad of sufficient size in the axilla and then bandaging the elbow firmly to the side, a great amount of leverage can be obtained, in spite of the shape and of the yielding of the wall of the thorax; but it is at the risk of injury to the important structures running down the inner side of the humerus; and there is a strong suspicion that many of the instances in which the brachial plexus has suffered have really been due rather to the pad than to the fracture. As a splint a pad is invaluable; but it is of very limited utility as a lever. Further, the elbow, as already mentioned, may be forced up for a short time so as to press the shoulder out, but it is generally found, after the strapping has been on a few hours, either that the pressure is intolerable or that something has yielded a little. The same may be said o Sayre's apparatus, in which a band of strapping round the arm is used as a fulcrum and the elbow as the long arm of a lever to force the shoulder back and out. In short, there is no thoroughly satisfactory method that can be applied to all cases alike; the best is to place the patient in the recumbent position so that the muscles are relaxed; the next, to make use of a moderate-sized axillary pad as a splint, and bring the whole arm a little behind the median line; if this fails, bringing the elbow forward and raising it forcibly may be tried; but probably the deformity will persist to a great extent.

The axillary pad should be wedge-shaped, about three inches thick at the base in the case of an adult, and should be held, base upwards, in the axilla by means of tapes tied over the opposite side of the neck. Then, the fracture having been adjusted as well as possible, and the arm and elbow held in the position it is wished to attain, the bandage should be fastened round the arm, close up to the axilla, and carried behind the back, round the thorax, including the forearm and arm, until the whole is encased in horizontal turns, drawing the elbow well, but not too forcibly, into the side. Finally, a few turns are taken obliquely under the forearm and the point of the elbow, over the opposite shoulder, to prevent dropping of the outer fragment; and the whole is secured either with starch or by stitching the layers together. Union is usually complete in children in about three weeks, in adults in four or five; but the arm should be carried in a sling for a week or so longer. If there is any rigidity about the shoulder-joint afterwards, the limb may be worked while the patient is under an anæsthetic.

Ellis's splint consists of a well-padded short crutch, which is pressed up into the axilla by a strap carried over the opposite shoulder; and of a band, embracing the arm, passing through two slits in the crutch, and then surrounding the thorax. The hand and elbow are supported by a sling in the ordinary way.

Sayre makes use of strapping spread on moleskin without any axillary pad. Two pieces are required, each three and a half inches wide. The first is sewn loosely in a loop round the humerus (the non-adhesive side next the skin) just below the axilla, and then carried behind the back round the chest until the circle is completed; this draws the shoulder back and acts as a fulcrum. Then, while an assistant brings the elbow forward and pushes it up, a second strip is carried from the opposite shoulder, obliquely across the first under the point of the elbow (which fits into a slit cut to receive it) and under the forearm as it lies upon the chest, up to the point from which it started. The theory is that when the elbow is forced upwards and forwards in this manner, the shoulder, owing to the way it is held, is driven outwards and backwards, in this way correcting the tendency to displacement inwards and forwards; but though this plan succeeds fairly well in ordinary cases, it is doubtful how far it is due to the leverage (figs. 105, 106, and 107).

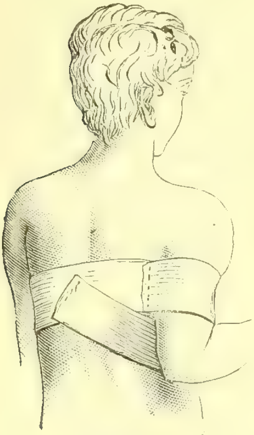

FIG. 105.

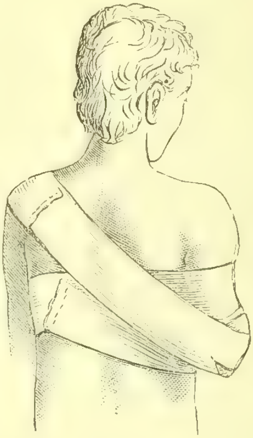

FIG. 106.

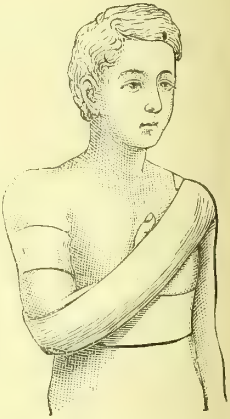

FIG. 107.

Sayre's method for fracture of the clavicle.

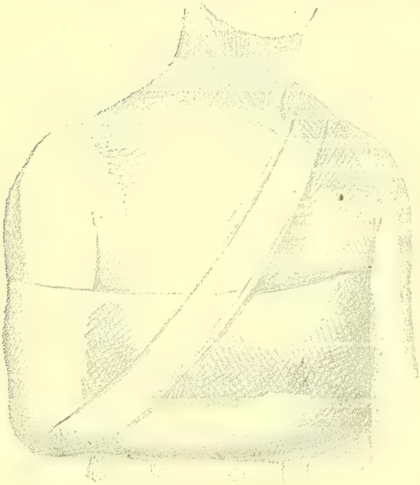

FIG. 108.—Pick's quadrangular bandage arranged as sling for arm.

The figure-of-eight bandage is practically abandoned; it is exceedingly uncomfortable, very insecure, and tends to depress still further the outer fragment. Pick's four-tailed bandage is very useful in the case of children. It is made of a stout piece of calico, long enough to go more than round the body, and (for an adult) fourteen inches wide. This is slit up from either end to within six inches of the middle, but one tail on each side is four inches wide and the other ten. An axillary pad is adjusted; the patient is placed in the recumbent position, with his arm by his side, and the forearm flexed across the chest; and then the bandage is arranged so that the point of the elbow is opposite the untorn strip in the middle (a vertical slit may be made in it here for the purpose of supporting the joint) and the broad ends surround the arm and the chest. These secure the arm to the side; and then the narrow ones are brought up, from under the elbow, and tied over the opposite shoulder. This bandage has the very great merit of being much less easily disarranged than most of the others (fig. 108).

Compound fractures of the clavicle are nearly always the result of direct violence, and may be either comminuted or complicated by the presence of injuries to other structures near. In one or two cases the fragments have been wired together.

Ununited fracture is very unusual, even when the deformity is very great, and the part is not kept properly at rest. The loss of power to the arm is by no means so marked as might be expected.

FRACTURE OF THE SCAPULA

Fracture of the scapula may involve the body, the acromion, the surgical neck or the coracoid process. Fracture of the anatomical neck (leaving the coracoid on the body of the bone and detaching the glenoid fossa only) is doubtful. Sometimes, in dislocations of the humerus, portions of the margin are chipped off (fig. 109).

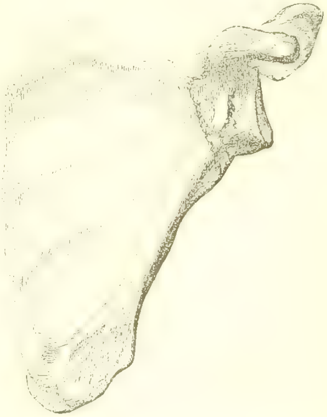

FIG. 109.—Fractures of the anatomical and surgical necks of the scapula.

Fractures of the body scarcely ever occur except from direct violence; they may be single, stellate, or comminuted, and may traverse the spine or not. The signs are usually distinct, though, owing to the dense fascia, and to the muscles attached to both surfaces of the bone, displacement is rarely considerable, and it is difficult to obtain distinct crepitus. Pain, swelling, and loss of power are always present.

A firm pad must be moulded on to the scapula to retain it in position by direct pressure, and the arm fastened to the side with a small pad in the axilla; but, unless there is great comminution or bruising, in a few days it is sufficient to have the thorax bandaged and to carry the hand or forearm in a sling. Some deformity commonly persists, but there is rarely any permanent loss of power.

Fracture of the acromion from direct violence is not uncommon, though many of the cases in which it has been found detached *post mortem* are really examples of rheumatoid arthritis with separation at the epiphysial line, or of delayed union. It may give way at the tip or close to the spine. The signs are quite definite: the arm hangs helpless by the side; the shoulder is flattened, the line of the acromion interrupted, the outer fragment depressed and freely movable, and the patient is either unable to abduct the arm or can only do so to a slight extent, and with great pain. Crepitus can be obtained by direct manipulation, either on pushing the elbow upwards or abducting and rotating the arm. If only the tip is broken all that is necessary is a triangular bandage to raise the elbow; but for the first few days it is advisable to strap the scapula closely to the thorax and to bandage the arm lightly to the side so as to prevent accidental movement. Union, if the fracture is near the spine, may take place by bone; in front of this it is nearly always fibrous, but this does not interfere with the strength or the range of movement of the joint.

The coracoid process may be broken off by direct violence or by muscular action, but it is very rare. In the former case, the injury, which may be caused either by a blow or by crushing, as when a cart-wheel passes over the axilla, is generally very extensive; in the latter there is scarcely any displacement, owing to the strength of the ligaments connecting the process to the clavicle.

Fracture of the neck of the scapula is almost equally rare. It can only occur by direct violence. The symptoms at first sight resemble those of dislocation of the arm, but the intense pain, undue mobility and crepitus, render the presence of a fracture certain. Moreover, the displacement returns as soon as reduction has been accomplished, unless means are taken to prevent it. Fracture of the surgical neck of the humerus can be excluded at once by the fact that the head of the bone in the axilla rotates with the shaft; but unless the coracoid process is movable it is almost impossible to make certain of the exact line of fracture in the scapula, especially as the amount of swelling is, generally speaking, very great, and dislocations are sometimes accompanied by injury to the glenoid fossa. The treatment is almost the same as in the other fractures of the scapula: the body of the bone must be fixed as well as possible; the elbow raised, to take the weight of the limb off; a small pad placed in the axilla to act as a splint, and the arm bandaged to the side. Passive motion should be commenced early, not later than the third week. Even then it is probable that there will be a considerable degree of stiffness about the shoulder.

FRACTURES OF THE HUMERUS

The Upper Extremity

Varieties.—These may involve the surgical or the anatomical neck; or the epiphysis may be detached from the shaft; or the intracapsular portion may be split longitudinally and the head dragged forwards so as to give the appearance of a dislocation.

Of these, fracture of the surgical neck is by far the most common, especially in the aged, when the medullary canal of the shaft is beginning to enlarge. Separation of the epiphysis can only take place under twenty; longitudinal fractures detaching the great tuberosity are not often met with unless there is a dislocation at the same time; while fractures of the anatomical neck are among the rarest known.

(1) *The surgical neck*

Causes.—Fractures of the surgical neck of the humerus may be the result either of direct or of indirect violence, of blows upon the shoulder or of falls upon the outstretched arm; muscular action by itself is very rarely sufficient. The line of separation lies between the base of the tuberosities and the upper margin of the insertion of the teres major. In general the fracture is transverse, but it may be oblique to a greater or less extent, and mpaction may take place, the upper end of the lower fragment being wedged nto the cancellous tissue of the tuberosities (fig. 110).

Displacement.—The displacement affects both fragments, but in very different degrees. In many cases there is scarcely any, the fracture is transverse and the broken ends are kept in the same straight line by the biceps tendon. In others, especially if the direction is at all oblique, it is very considerable; and it may be a matter of great difficulty to retain the fragments in position. The upper of the two is abducted by the supra-spinatus and rotated outwards by the infra-spinatus and the teres minor. The lower is drawn upwards chiefly by the deltoid, and inwards by the muscles passing from the thorax to the upper part of the arm, so that it may completely overlap the other and form a projection that stands out under the skin in the front wall of the axilla.

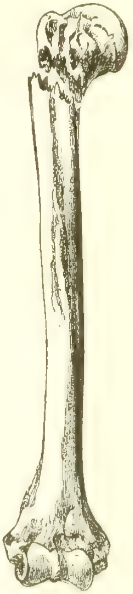

Fig. 110.—Fracture of neck of humerus.

Symptoms.—In some instances the amount of shortening is considerable, as much as three-quarters of an inch, though this is unusual. The rounded shape of the shoulder is not lost, but there is a depression some little distance below the acromion; the axis of the limb is altered; the elbow points backwards and outwards, though it may be brought into the side with very little pressure; and there is a certain amount of fulness about the front fold of the axilla. Undue mobility and crepitus are easily made out if the fragments are not impacted; the glenoid fossa is still filled by the head of the bone, and the upper end of the lower fragment can be felt projecting in front. Loss of power is complete, and often the pain is very severe, running down the arm, owing to pressure upon the brachial plexus.

Many of these symptoms are wanting when the fracture is impacted but there is great pain, especially at the seat of injury, complete loss of power over the limb, a slight amount of deformity and distinct shortening. Extravasation is extensive, as a rule, and the swelling very distinct, especially on the inner side of the arm. In some cases it may be due to rupture of the circumflex arteries; in others it is merely the result of bruising and laceration of the muscles.

Treatment.—No attempt should be made to reduce an impacted fracture unless the axis of the limb is seriously distorted. It is often difficult to bring the fragments into good position, and always harder to keep them there. All that is needed for such injuries is a pad in the axilla to act as a support, and a bandage round the arm to confine it to the side. In all fractures of the humerus the hand should be carried in a sling, but this should never be allowed to extend under the elbow.

When there is no impaction the upper fragment is practically out of control. It is so short and so deeply covered that very often it is difficult to be certain how far it is displaced. More may be done with the lower, though sometimes it is impossible to bring this into position and adjust it properly. It may be necessary to place the patient under an anæsthetic and to abduct and raise the arm from the side before the ends can be disengaged. The displacement inwards is most easily met by placing a firm pad in the axilla, or, as Erichsen suggests, a piece of leather bent into the shape of a U, one side applied to the thorax and the other to the arm. If this is placed well up in the axilla, and if, at the same time, the elbow is carried slightly forwards and fastened to the side of the chest by means of a bandage, the upper end of the lower fragment is carried outwards and backwards and the broken surfaces can generally be brought into good apposition. Then the hand is arranged in a sling, as already mentioned in the case of impacted fractures, and a cap of gutta-percha, or, what is better, as it is not so hot, of poroplastic felt, adjusted over the shoulder and down the arm, taking care not to bring it so far on to the neck that it becomes displaced by the movements of the head, or so far on to the thorax that it loses its grasp on the arm. This is fastened by a bandage carried round the opposite side of the chest. It must be admitted, however, that even when every care is used, union in a faulty position cannot always be avoided. Bandaging the hand and forearm is quite unnecessary (fig. 111).

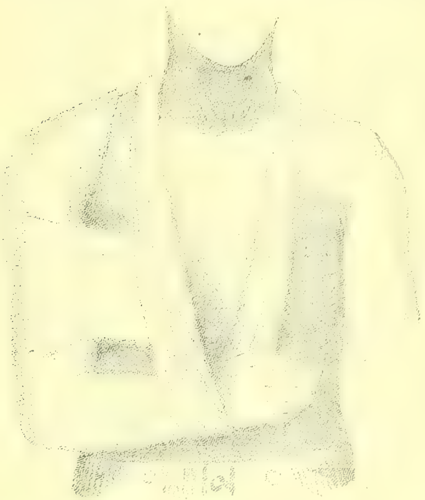

FIG. 111.—Bandage with shoulder-cap and sling for fracture of surgical neck of humerus.

Union is generally complete in from five to six weeks, but the arm remains stiff and powerless for some time after. Passive motion should be commenced at the third week at the latest; in many cases it answers well to begin even before this, very quietly and gently, with the object rather of preventing the formation of adhesions by straightening out the folds of the capsule than of breaking them down. If this is not done, the joint is sure to become rigid, owing to the mobility of the scapula, and it may be necessary, at a later period, to place the patient under an anæsthetic and work the part thoroughly. Delayed union and even complete failure occasionally occur.

(2) *Separation of the upper epiphysis*

This is not an uncommon accident under twenty years of age, and presents practically the same features as fracture of the surgical neck. True crepitus, however, is wanting, even when the line of separation runs between the cartilage and the bone; only an indistinct soft rubbing can be felt, and the upper end of the lower fragment, when it is made to project beneath the coracoid, is smooth and rounded instead of being sharp and angular. In some instances there is considerable difficulty in reduction; the under surface of the upper fragment is cup-shaped and prolonged downwards upon its inner and anterior aspect, and it is said that the edge of the lower fragment may be caught by this. To release it the arm must be forcibly abducted and extended. In other cases it arises from the upper end of the lower fragment being driven through the capsule.

Union, especially about the time of puberty, is very likely to be osseous, impairing the growth of the limb. This, however, is not invariable, probably because in many of these cases the injury is really a fracture, running through the recently formed bone without involving the cartilage. Complete failure has been known, and even suppuration, although the skin was unbroken. In two instances in which union had taken place in so distorted a position that the arm was almost useless, Bruns separated the fragments again, resected part of the diaphysis, and wired them together with a good result. In one or two cases in which the bones could not be brought into proper apposition, the joint has been laid open from the front, the interposing tissues divided, and the two fragments fixed together by means of a long drill driven through the skin. This was removed on the eighth day, as soon as sufficient lymph had been poured out to make the ends secure.

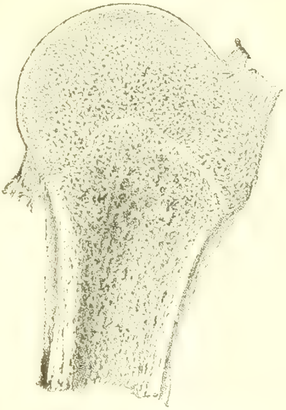

Fig. 112.—Vertical section through upper epiphysis of humerus, showing the shape of the end of the diaphysis.

It is possible for the joint to escape without being opened; the capsule is so firmly attached to the epiphysis that it may remain in connection with it, stripping off the periosteum from the shaft. More often it gives way upon the inner side.

(3) *Fracture through the tuberosities*

Longitudinal fractures through the upper end of the humerus are not common. Sometimes, however, the great tuberosity is torn off by the contraction of the muscles when the head of the bone is dislocated; and occasionally the part is split by direct violence. When this occurs, the great tuberosity alone may be detached; or the line of separation may run through the head, or even along the bicipital groove, so that most of the articular surface is broken off, and the small tuberosity is left almost by itself on the end of the shaft.

Symptoms.—The character of the displacement is the same in all, though it varies in degree. If the tough tendinous periosteum at the insertion of the muscles is not torn there is exceedingly little; in general it is very considerable. The breadth of the shoulder is the most prominent feature; this is immensely increased owing to the way in which one fragment is pulled forwards and the other backwards; and the axis of the limb is altered so that the elbow points backwards and outwards. Very little pressure, however, is required to bring it again into its normal position. As a rule there is no shortening, but there may be a great amount of bruising and extravasation, especially in cases in which the injury is caused by direct violence. Loss of power is complete. Crepitus is sometimes difficult to obtain on account of separation of the fragments; but the most characteristic sign is the presence of a bony projection under the coracoid in front, resting on the anterior surface of the glenoid fossa, and under the acromion behind, with a deep furrow in between. The anterior follows the movements of the shaft, and corresponds more or less to the head of the bone; the posterior is the greater tuberosity drawn upwards and backwards by the muscles attached to it. The diagnosis of this peculiar accident requires especial care, as subcoracoid dislocation of the head of the humerus may be associated with it; and, if it is not made out, serious deformity is certain to result.

Treatment.—If the displacement is only slight, all that is necessary is to place a pad in the axilla as a splint, and to support the elbow, either by means of a triangular sling or a four-tailed bandage; but this is quite exceptional. In general it is very considerable, and bony union may fail, as it is not at all easy either to bring the fragments together or to maintain them in that position. The simplest plan is to place a pad in the axilla, and try, with the aid of a bandage round the upper part of the humerus, to bring the upper end of the lower fragment backwards and outwards, while an attempt is made to press the other forwards, by strapping a pad firmly on it. If this fails the only alternative is to place the patient in bed, with a small pillow under the head, and to keep the arm extended and rotated out so that the hand lies on its dorsum. Even if union is bony it is a long time before full use of the joint is regained; the fracture often involves part of the articular surface, and lips of callus are thrown out around it; or the capsule becomes thickened and rigid, so that the range of movement is limited; or rheumatoid arthritis sets in afterwards and leaves the joint permanently crippled.

(4) *Fracture of the anatomical neck*

Fracture of the anatomical neck is exceedingly rare and can only be produced by direct violence; most of the cases have occurred in old people, or at any rate after middle life, probably owing to the changes that take place in the substance of the bone. The line of separation is supposed to follow the anatomical neck of the humerus, but it nearly always lies partly inside, partly outside the capsule. It is very doubtful if such a thing as intracapsular fracture, in the strict sense of the term, has been proved. The head of the bone does not undergo necrosis, though union may be only fibrous or may fail completely; impaction is common, the upper fragment being driven into the substance of the tuberosities; where this does not take place an amount of nutrition sufficient to maintain life, though it is seldom enough to repair the injury, is kept up by the reflected portion of the capsule on the under surface of the neck.

Displacement.—In a few extraordinary instances the position of the upper fragment has been found completely reversed, the cartilaginous surface, that is to say, facing the tuberosities. It is very difficult to see how this is produced, but it is almost certain that it must be the result of forces acting subsequently to the fracture, perhaps long after. In other cases it is very slightly displaced, unless there is impaction, when it may be driven so far into the substance of the tuberosities as to split them in two. The lower fragment is held by the attachment of the capsule and the insertion o the muscles immediately below, so that it is only drawn upwards and inwards to a very slight extent.

Symptoms.—The most prominent symptoms are those due to the contusion. The loss of power is complete; the shoulder is swollen, tense, and painful, signs of bruising show themselves very soon, especially along the margins of the deltoid, and the whole of the upper and inner part of the arm may be blackened. If anything, there is a slight amount of shortening, and probably this is greater in impacted fracture; deformity is very little marked and is easily rectified; there is no undue mobility; but when the arm is raised from the side, and the head of the bone is felt in the axilla, a certain amount of irregularity can usually be detected. Crepitus is easily produced, unless there is impaction, by pressing the elbow upwards so as to bring the broken surfaces in contact.

Kind of union.—If the fragments are impacted, union, generally speaking, takes place by bone. In other cases it may fail completely, the two surfaces becoming hard and smooth from constant friction; or there may be a certain amount of fibrous tissue formed between them; or the head may be enclosed by a growth of bone, like a coronet, around it, so that it becomes quite fixed. In true intracapsular fractures union can hardly take place without impaction.

Treatment.—No attempt should be made to reduce impaction; it is true that the shortening and the deformity are generally speaking greater, but they are never serious, and impaction affords the surest promise of bony union. In other cases all that can be done is to protect the shoulder, and carry the forearm in a sling, with the elbow bandaged to the side, but no axillary pad. Care must be taken not to tear the capsule of the joint any farther, as union depends upon this to some extent. It is possible that the head of the bone may remain loose in the cavity of the joint, and give rise to such an amount of inconvenience that its removal may be required; but such an occurrence is very doubtful.

Fracture and dislocation combined

Fracture of the surgical neck of the humerus with subcoracoid dislocation occurring at the same time is not so rare an accident as might be imagined. Nearly seventy cases of it have been recorded. In all probability the dislocation occurs first, and the neck of the bone gives way from a continuance of the same force. The injury itself is not an easy one to make out, as all the ordinary signs of dislocation that depend upon the alteration in the axis of the limb are not only wanting but point directly to fracture. The most characteristic feature is the absence of the head from the glenoid fossa.

The patient must be placed under an anæsthetic, and every effort made to reduce the dislocation by squeezing the bone in the direction of the glenoid fossa when all the muscles are relaxed. If this fails it is generally recommended to put the fracture up, and when it is fairly well united to make another attempt; but at any rate in the case of a young and healthy patient, to whom it is of some consequence to retain full use of the limb, it is questionable whether it would not be advisable to open up the joint and replace the head of the bone at once.

Compound fractures

Compound fractures of the upper extremity of the humerus are not common, except as a result of gunshot injuries or of machinery accidents. The latter generally require amputation as soon as the shock has passed off, but the question must be decided in each case by the condition of the soft parts. Where they are not seriously hurt every attempt must be made to save the limb, even if the bone is extensively splintered. The ends may be removed, the head of the bone excised, or resection of a more or less formal character be performed with excellent results. Six inches of the bone have before now been removed.

Where, on the other hand, the soft parts are extensively injured, the skin stripped up, and the muscles badly torn, it is very doubtful, even if there is no comminution, whether any attempt of the kind would succeed in leaving a serviceable arm. The artery may be divided and tied at both ends ; and the same may be done with the vein, without amputation being necessary, if the collateral circulation has not been injured—practically, that is to say, where the fracture is not due to direct violence. The nerves rarely give way unless the arm is almost torn off ; if, however, one of them has been divided, the two ends should be carefully sutured together with catgut.

FRACTURE OF THE SHAFT OF THE HUMERUS

These are generally due to direct violence ; sometimes they are caused by falls upon the elbow, and in a few instances they have been known to occur from muscular contraction ; but though this is more common here than in any other bone, the total number is not large.

Displacement.—The seat of injury is more often below the insertion of the deltoid than above, and the fracture is generally oblique from above downwards and outwards. In children, however, and in fractures from muscular action, it may be nearly transverse. The lateral displacement is almost entirely dependent on the direction of the fracture, and the action of the muscles. In injuries above the deltoid it is worse than in those below ; in the former the muscles that pass from the thorax to the arm pull the upper fragment inwards, while the deltoid carries the lower one outwards, and raises it at the same time ; in the latter, these muscles antagonise each other to a great extent, so that the parts may remain in apposition. Shortening is rarely considerable, and in transverse fractures, especially if the periosteum is not torn, is absent altogether.

Symptoms.—All ordinary symptoms are well marked. The deformity when the arm is hanging by the side may not be conspicuous, but crepitus, undue mobility, ecchymosis, intense pain, and utter helplessness are nearly always present. In general there is no difficulty in feeling the fragments through the skin. The artery rarely suffers, but the musculo-spiral nerve, as might be expected from its peculiar relation to the bone, is often hurt, and still more frequently is injured by being compressed in the callus that is thrown out.

Treatment.—Fractures of the upper part of the shaft are treated in the same way as those of the surgical neck ; only a short inside splint, coming down to the internal condyle, is better than an axillary pad ; and the shoulder cap should be continued down the limb to the elbow, and be made to fit accurately round at least two-thirds of the arm. When they occur lower down, various appliances may be used. Four short, well-padded, wooden splints may be adjusted round the limb, the inner one reaching from the axilla to the inner condyle, the outer from the acromion to the external, and the anterior resting on the bend of the elbow. When these are secured by webbing-straps and buckles, or even with sticking-plaster, movement is hardly possible. Instead of the three outer ones, Gooch's splint may be employed. This consists of narrow strips of wood fastened parallel to each other, on one surface of a piece of wash-leather or moleskin, after the fashion of some kinds of dinner mats, so that it can easily be rolled round a limb. In several instances I have used the ornamental flower-pot holders that are made of diagonal interlacing bars, and can be opened or closed to any requisite width (fig. 113). A layer of cotton-wool or of lint must be placed round the arm first, and care must be taken to cut away sufficient material to accommodate the elbow and the axilla; but when this is done they can be fixed with the greatest ease, and they are sufficiently elastic to fit without being unpleasantly rigid. Poroplastic felt may be used in the same way. Plaster-of-Paris is rather heavy. With all of these the hand must be carried in a sling, and the elbow allowed to drop, and of course the condition of the circulation in the hand and fingers must be carefully watched.

Sometimes there is a considerable amount of shortening in oblique fractures. This can only be prevented by confining the patient to bed; hanging weights upon the elbow is useless so long as he is allowed to move about. The arm must be laid upon an inside splint, a stirrup fixed above the elbow, and a weight carried from it by means of a cord running over a pulley placed at a convenient angle by the side of the bed.

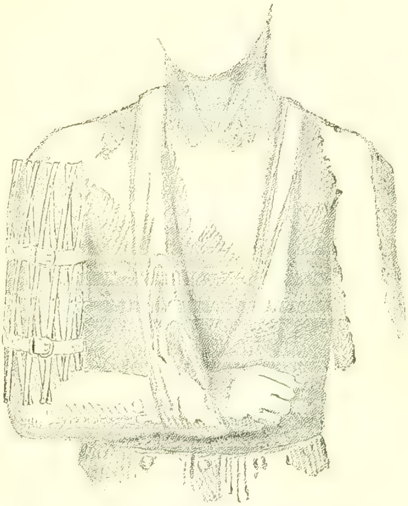

Fig. 113.—Splint and sling for fracture of the shaft of the humerus.

Where the upper fragment is much displaced or where, from the age of the patient or other causes, it is not considered advisable to carry a bandage round the thorax, Middeldorpf's triangle is the best contrivance. This consists of a light, well-padded triangular framework; one side runs down from the axilla to the hip, a second from the axilla to the elbow, and a third joins the lower ends of the other two. The object is to secure the elbow and shoulder, and at the same time keep the arm fixed in abduction.

Union generally takes place in five or six weeks, but total failure and false joint are more common in the shaft of this bone than in any other. It has nothing to do with the position or direction of the nutrient artery, nor is it in any way the result of separation of the fragments for want of support at the elbow-joint. It has been assigned, with more probability, to the fact that neither the shoulder nor the elbow-joint is properly fixed, so that more movement takes place at the seat of injury than is advisable; but it is very doubtful whether the means adopted to obviate this do not do more harm than good. Angular splints, for example, as Hamilton pointed out, soon make the elbow stiff, so that if the forearm drops at all, or if any attempt at movement is made, the fracture yields, and not the joint. Certainly, in many instances of ununited fracture, the elbow-joint is stiff. Further, if an inside angular splint is applied to the arm and then the hand placed in a sling, the elbow becomes abducted at once, and this movement takes place more easily at the seat of fracture than it does at the shoulder. Probably the real cause in the majority of instances is the interposition of some foreign substance—generally speaking, muscle; and its frequency may be explained by the very extensive surface of the shaft that affords attachment to the brachialis anticus and triceps. If the direction of the fracture is in the least oblique, either fragment may be easily driven so far into the soft parts that it is almost impossible to disengage it. In one or two instances, the musculo-spiral nerve has been found between the fragments.

The treatment depends upon what can be made out with regard to the position of the fragments; if they are in apposition with each other, any of the methods already mentioned in speaking of delayed union may be adopted; but if it is practically certain that there is some intervening substance, union is impossible until this is removed. It is essential, before attempting any operation of this kind, to encourage the circulation through the limb by galvanism, friction, and whatever kind of movement is possible. When an arm has been confined in splints, or carried in a sling for many months together, the nutrition becomes so much impaired that, not unfrequently, even such a proceeding as wiring the fragments is entirely unattended by the formation of callus.

Fracture of the Lower End of the Humerus

A certain amount of confusion has arisen with regard to these from the variety of names employed. This may be avoided by making use of the term epicondyle for that part of the bone (internal or external) which lies outside the capsule and gives attachment to the muscles; reserving the word condyle to include part of the joint.

The line of fracture may either lie wholly outside the capsule of the joint or may traverse this in part.

1. In the former class are included transverse fracture above the olecranon fossa (supra-condyloid): separation of the internal epicondyle, and separation of the corresponding epiphysis by itself. The external epicondyle does not project sufficiently.

2. In the latter are T-shaped fracture; separation of either condyle, the line passing from above the corresponding epicondyle obliquely into the centre of the joint and detaching either the capitellum or the trochlea; and separation of the lower epiphysis. It is true that, owing to the firmness with which the capsule of the joint is fastened to the margin of the epiphysial cartilage, it is possible to detach this from the shaft by stripping up the periosteum, without opening the synovial cavity; but it is very unlikely that this really happens in cases of fracture. Separation of the epiphysis for the internal epicondyle may take place by itself without involving the joint, but if the whole mass is detached, or if the three outer ones together are separated, there is nearly certain to be some rent in the synovial membrane.

The line of attachment of the fibrous capsule surrounds the coronoid depression on the front of the bone, and, on either side, incloses the trochlear and capitellar surfaces, skirting the cartilage of the latter very closely. Behind it includes the whole of the olecranon fossa, but not that part of the bone that lies above and behind the radial surface; this is altogether uncovered. The line of junction between the epiphysis and the shaft separates off both epicondyles, and the whole of the cartilaginous surface, running transversely across the centre of the bone, and turning upwards at either end; so that, as the external epicondyle is never detached by itself, separation of the internal is the only form of injury that can take place without throwing an immense strain upon the capsule, a strain so great that practically it always gives way.

The relative situation of the olecranon and the two epicondyles, as compared with those on the opposite arm, is of the highest importance in the diagnosis of injuries in the neighbourhood of the elbow-joint. Measurements should be taken in all positions of the limb; and the transverse diameter, from the tip of one epicondyle to the tip of the other, should not be neglected.

Fractures of the lower end of the humerus are more common in children than in adults; they are often complicated with dislocations; and if the diagnosis is not made at once they are always attended with such a degree of swelling that it can hardly be made at all. Impairment of mobility is a very common result, especially when the joint is involved; the fragments are exceedingly difficult to retain in position; a large amount of callus is often thrown out by the extra-articular part, so that the fossæ are filled up and the bones lock too soon; and the capsule is very likely to become thickened and rigid from the development of extra-articular adhesions. In children an accident to the elbow is not an uncommon precursor of tubercular mischief.

1. *Fractures external to the joint*

Transverse fracture above the condyles: supra-condyloid. In some cases this involves the reflection of the synovial membrane in the olecranon fossa; usually it is situated a little above.

It is generally produced by falls upon the elbow, the tip of the olecranon perhaps acting like the apex of a wedge, splitting the bone across; but it may be caused by direct violence, or by the cross-breaking strain in over-extension of the elbow-joint, in place of dislocation. The line of separation is fairly transverse from side to side, but very often is oblique from above downwards and forwards, and this determines the displacement.

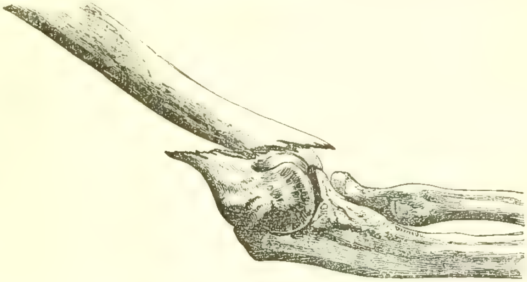

Fig. 114.—Fracture of the lower end of the humerus.

The deformity is almost the same as that of dislocation of both bones of the forearm backwards, but is not at the same spot. The elbow-joint is flexed and the hand generally pronated; the olecranon projects behind with a great depression above in which the tendon of the triceps stands out distinctly; in front there is a prominence due to the lower end of the upper fragment; but as soon as the injury is examined with the hand it is found that the relation of the olecranon to the two condyles is unaltered, and that the projection in front is not the articular surface of the humerus, but is on a distinctly higher level. In addition to this, the length of the humerus is altered; crepitus is present; there is undue mobility, instead of the joint being fixed; and, what is most important of all, if the deformity is rectified, it returns as soon as the arm is released. In cases in which the amount of swelling is so great as to obscure all the bony prominences, this test may be relied on absolutely; the only other injury in which it is present is dislocation backwards combined with fracture of the coronoid process, and this is distinguished by the fact that the condyles of the humerus still retain their relation to the shaft.

When the line of fracture runs in the opposite direction across the bone, the symptoms are not so characteristic, as there is no projection of the olecranon; but all the ordinary signs of fracture—shortening, crepitus, undue mobility, and pain—are well marked.

Treatment.—Reduction is easily effected, but when the fracture is oblique there is some difficulty in maintaining the length of the limb, owing to the strength of the muscles. Swelling is often very considerable if the fracture is not put up at once. It may not be so bad as when the injury traverses the joint, but, if it is at all serious, the patient should be confined to bed, and the limb fastened lightly to an inside angular splint. Cold applications are generally recommended, and they are of great use at first; the vessels become constricted under their influence, the extravasation ceases, the exudation of lymph is limited and the swelling of the joint is checked: but, after the first few hours, gentle compression, if it can be managed with safety, is much more effectual. It requires, it must be confessed, the utmost care; a thick layer of cotton-wool must be used, the fingers must be constantly watched to see that the circulation is being carried on properly; the pulse at the radial must be felt from time to time, and the bandages must be put on after the limb is in position (most of the disastrous cases of gangrene have been caused by the dressing being applied to the limb when it was extended, so that as soon as it was flexed the bandage cut deeply into the fold of the joint); but if it is properly carried out there is nothing that succeeds so rapidly or so surely in removing the swelling and preparing the limb for a more permanent apparatus. It is of great importance to limit the amount of exudation poured out around the end of the bone; sometimes, especially when the fracture involves the joint, it is so excessive that the lower part of the humerus appears to be converted into an almost shapeless block, and movement is checked in all directions.

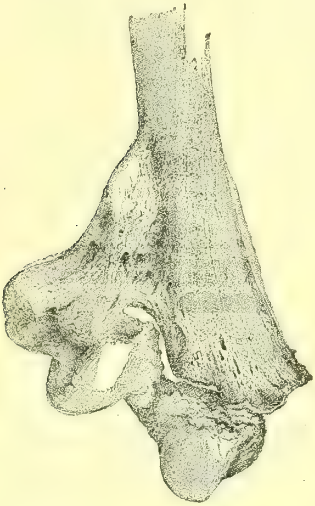

Fig. 115.—Common form of malposition after fracture of lower end of humerus.

The most convenient form of splint is rectangular, made of some plastic material, arranged along the posterior aspect of the arm and the under surface of the forearm from the axilla to the wrist. With this there should be a short anterior one down the arm, thickly padded opposite the bend of the elbow, so as to correct as far as possible the tendency to forward displacement of the upper fragment. The hand must be carried in a sling. In some few cases an anterior angular one appears to answer better, but the ordinary metal or wooden inside splint with a joint at the bend is of little use unless the patient is confined to bed.

Passive motion should be commenced not later than the end of the second week, but extraordinary precautions must be taken. There is danger on both sides: if the elbow is allowed to become stiff, non-union may occur, though it is not so frequent as higher up in the shaft; if, on the other hand, the seat of injury is not securely held, the soft callus yields, and is liable to become broken up and absorbed. If the fracture is low down, extension is often limited, owing to the way in which the olecranon fossa becomes filled up, but this is not nearly so bad as in T-shaped fractures; and even in the worst cases great improvement takes place in the course of a year or two.

Separation of the internal epicondyle.—This occurs more frequently than is generally suspected, but from its being associated either with extensive bruising, or with dislocation, the symptoms to which it gives rise are often overlooked. It may be produced by direct violence (a fall or a blow on the inner side of the elbow-joint), in which case there is not much separation of the fragments, or by dislocation of the bones of the forearm outwards, when it may be dragged a considerable distance. Sometimes it is wrenched off by muscular action alone.

The symptoms and importance of this accident depend upon the way in which it is caused. So long as the line of fracture lies entirely outside the capsule, as it does in the majority of instances, it is of little consequence. Movement in the direction of flexion and extension is free, and almost painless until the extremes are reached and the tension falls upon the fibres of the internal lateral ligament. Pronation is very painful. Sometimes an interval can be felt in following down the line of the internal condyle; and occasionally the detached portion can be plainly made out, and moved freely from side to side. Crepitus can only be obtained when the degree of separation is slight. When, on the other hand, the violence is direct, the swelling may be so great as to obscure the outline of the bones; and, not improbably, in many of these cases the fracture extends farther outwards into the substance of the bone, so that the injury approximates in character to the separation of the internal condyle.

In most cases it is sufficient if the forearm is carried in a sling, with the elbow at a right angle. Union is only fibrous if the epicondyle has been dragged down to any extent by the traction of the muscles, but this interferes very little with the strength of the arm. When the cause is direct violence a large amount of callus is sometimes thrown out, probably because the splintering extends farther than is apparent; and there may be some impairment of movement at the elbow-joint, even when there was no evidence of its having been involved. I have known one instance in which, for a long time after, there was persistent pain in the course of the ulnar nerve.

Separation of the epiphysis for the internal epicondyle may take place up to the age of eighteen or nineteen. The symptoms are practically the same.

2. *Fractures that involve the joint*

T-*shaped fracture.*—In this there is a transverse fracture passing across the lower extremity of the humerus, and a vertical split running down from it into the centre of the joint, separating the two condyles. It is always the result of direct violence; the apex of the olecranon and the ridge that traverses the greater sigmoid cavity from before backwards are driven violently against the lower end of the humerus, and split the bone like a wedge. I have known the T incomplete, and only the vertical portion of the fracture produced in this way.

The symptoms are the same as those of the supra-condyloid fracture, of which it seems a more severe form; but the swelling is much greater; the condyles can be moved independently of each other and of the lower end of the shaft; the displacement is more serious, and is even harder to rectify; and perfect freedom of movement is rarely restored.

In many of these cases, owing to the great rapidity with which the swelling sets in, and the enormous size the joint assumes, all that can be done is to lay the arm on a pillow, or to fasten it lightly on an inside splint, and try to limit the amount of exudation by means of cold and pressure. The joint must be kept at a right angle, or even a little less, so that in case anchylosis does take place, the arm may be in the most useful position. With the elbow fixed at this angle the hand can be placed behind the head, and brought sufficiently near for the patient to feed himself; if it is more open the joint is almost useless. The earlier the fracture is set, the better the prospect of good adjustment. The olecranon must be dislodged from between the fragments, and these must be brought close together and into the same straight line with the shaft. A great deal may be done by careful readjustment up to the end of the first week; and some improvement may be effected for a few days longer; but, as a rule, at the end of a fortnight the fragments are too firmly fixed to allow anything farther. Passive movement must be commenced as soon as possible, the joint being thoroughly, but quietly, flexed and extended once a day, while the fragments are held in position as firmly as they can be. Hamilton states that it should be commenced by the seventh day.

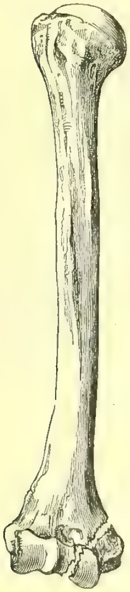
Fig. 116.—Fracture of the internal condyle of the humerus.

Fracture of the internal or external condyle.—In this the line of separation runs from above the corresponding epicondyle through the articular surface of the humerus into the middle of the joint. The internal can only be detached by direct violence; the external may be separated either in this way, or by a fall upon the hand (fig. 116).

The symptoms are very much the same as those of the T-shaped fracture, but less severe, as there is scarcely more than half the injury. The displacement varies very much: if the trochlear surface is left intact, it is very slight; if, on the other hand, the articulation for the ulna is separated from the shaft, it may be sufficient to suggest backward dislocation of both bones. Treatment must be carried out on the same principle, and early passive motion must be insisted upon.

When the internal condyle is broken off, leaving merely the capitellum, the limb may be kept in a position of extension with advantage, at least for the first fortnight, and then gradually flexed. Care must be taken to preserve the outward angle that the forearm makes with the arm.

Separation of the lower epiphysis.—In infants this is not uncommon; the whole of the cartilaginous mass at the lower end of the humerus is detached from the shaft, without of necessity the joint being opened, though it probably is in nearly every case. In children it is equally frequent; but the line of separation rarely corresponds exactly, for its whole length, to that of the epiphysis; and the internal condyle is seldom separated with the rest. The outer part is the one that suffers as a rule; it consists of three osseous nuclei, that which represents the capitellum being much the largest and forming a considerable share of the trochlea: the line of fracture runs from above the external epicondyle into the centre of the joint, to one side or other of the trochlear surface; if the latter is included, the lower fragment is carried backwards with the bones, so that it closely resembles a dislocation.

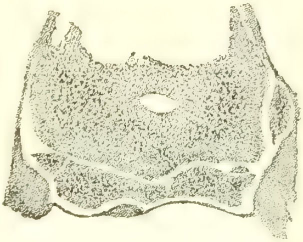

FIG. 117.—Vertical section through lower end of humerus at fifteen years of age, showing the relative size and position of the epiphyses.

The most frequent cause is violent abduction or adduction of the forearm combined with hyperextension. The symptoms are nearly the same as those of the supracondyloid and condyloid fractures; and, as a rule, the same treatment is required. Only where the line is immediately above the joint, and it is difficult to retain the fragments in position, it is recommended to put up the injured limb in a position of complete flexion, care of course being taken not to interfere with the circulation.

In addition to these, other forms of fracture are occasionally met with which do not admit of classification. Sometimes the lower end of the humerus is completely comminuted; or dislocation of the radius, or ulna, or both together, occurs at the same time; or the injury is complicated by fracture of the bones of the forearm.

Compound fractures into the elbow-joint.—These are not uncommon, and frequently the ulna, or the radius, is involved as well as the humerus. The treatment, as in the case of compound fractures into other joints, must be guided by the age and constitution of the patient, and by the extent of injury to the soft parts and the bones respectively; but this is modified to a certain extent as regards the elbow by the excellent results that are obtained by excision. If there is but little comminution, and the wound is small and clean cut, the part should be thoroughly cleansed with corrosive sublimate, the wound sealed with a dressing of wood-wool or some similar absorbent material, and the limb arranged upon an angular splint, and slung with a counterpoise from a pole over the bed, as in an excision. But if the bone is extensively injured, or the skin much bruised, so that the amount of movement in the joint afterwards is a matter of some doubt, it is better to excise the part at once. Amputation is only required when the soft tissues are destroyed to such an extent that there is no prospect of the limb recovering.

FRACTURE OF THE RADIUS

This may involve the head, the neck, the shaft above the insertion of the pronator radii teres, or the lower extremity. When the shaft is broken the ulna, generally speaking, gives way too.

Fractures of the head are very rare, but occasionally they are produced either by direct violence crushing the external condyle or by falls upon the hand. They have been found in several of the instances in which the coronoid process was broken. The line of fracture is usually longitudinal, splitting off more or less of the circumference of the bone.

Fracture of the neck of the bone is still more uncommon, though it is an injury that is often suspected during life. It may occur in children or in adults, probably from direct violence, though one or two instances are recorded in which it has been due to falls upon the hand. The head of the bone is unduly movable and does not rotate with the shaft; pronation and supination are impossible, and when the hand is moved in either direction there is intense pain at the seat of injury; a slight amount of crepitus is usually present. I have met with one instance in which the upper epiphysis was separated, the external condyle of the humerus being considerably crushed at the same time. The only treatment that can be adopted is to retain the elbow-joint in a light form of rectangular splint with a firm pad over the front of the forearm and to commence passive motion as in fractures of the lower extremity of the humerus. If, owing to the contraction of the biceps, the displacement cannot be rectified in any other way, the arm must be put up fully flexed; but it must be recollected, when passive motion is begun, that the muscle is very likely to have become rigidly contracted from prolonged rest. The position of the posterior interosseous nerve in relation to the bone must not be forgotten in connection with this fracture.

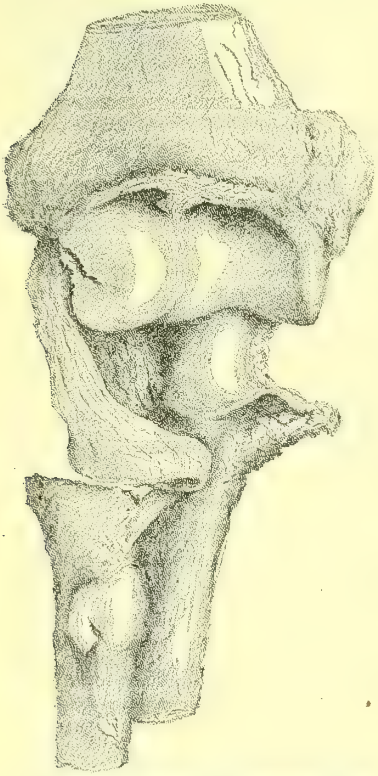

Fig. 118.—Separation of upper epiphysis of radius with crushing of capitellar surface, and external epicondyle.

Fractures of the shaft of the radius alone are due either to falls upon the hand or blows upon the arm; and may take place either above or below the insertion of the pronator radii teres. In the former case the upper fragment is acted on by the supinator brevis and the biceps, the lower by the pronators, so that the relative position of the radius and ulna is not the same above and below the seat of injury. In the latter, the upper fragment, owing to the attachment of the pronator teres, is not much displaced; but the lower is tilted inwards towards the ulna, partly by the supinator longus, partly by the pronator quadratus.

So long as the ulna is intact the amount of deformity is very slight. The other signs are well marked: there is intense pain over the seat of injury; pronation and supination are impossible; when the hand is grasped and made to rotate, the upper end of the radius does not move with it; and crepitus can be felt at once.

Fractures of the upper part of the bone should, if possible, be put up in a position of complete supination. The upper fragment is already in that position, and if the lower is partly pronated it is clear that a certain amount of supination must be lost, and though this can be supplemented to a great extent by rotation at the shoulder-joint, especially after long practice, the movement at the elbow is exceedingly awkward. It seldom happens, however, that patients will endure it; if they are confined to bed the arm may be laid on its back and completely extended; if not, all that can be done is to fit a posterior rectangular splint down the arm and forearm, and to arrange a sling so that the hand, resting on its dorsum, is as much in front of the median lateral line of the body as the elbow is behind.

When the seat of injury is below the insertion of the pronator teres, the danger is that the upper end of the lower fragment may be drawn inwards, and at length unite with the ulna, when, of course, both pronation and supination are lost. To prevent this, straight back and front splints must be used, wider than the limb, so as to take off all lateral pressure, and well padded, especially down the centre, so that the muscles may be squeezed as far as may be into the interosseous space; and the limb should be put up midway between pronation and supination, that is to say, with thumb uppermost and the dorsum of the hand looking forwards. The sling should only take the forearm, so that the hand may hang down in a position of adduction.

Fracture of the lower end of the radius.—With the exception of the clavicle this bone is broken more frequently than any other. The fracture is usually transverse from side to side, though in the vertical direction it may incline from above downwards and forwards, and it nearly always lies within an inch of the carpal surface. The size of the lower fragment, however, varies considerably: it may be merely a plate of bone carrying the articular cartilage.

The cause is almost always indirect violence, a fall upon the hand. If the palm is towards the ground the displacement is dorsal (Colles' fracture), and it may be impacted, non-impacted, or comminuted; if, as occasionally happens, the hand is doubled underneath, so that the back is downwards, the lower fragment is forced in the opposite direction.

Colles' fracture.—For many reasons this is of special interest: it is exceedingly common; it is much more often met with in women past middle life than in men; it is distinguished by displacement of a very striking character; and it often leaves behind it unsightly deformity and a very serious degree of stiffness.

The structure of the lower end of the radius favours its occurrence. The compact tissue of the shaft is firm and strong, but over the articular end it is scarcely thicker than paper, and one part passes very abruptly into the other. In men of good muscular development the bony ridges in the back and at the sides strengthen it sufficiently; but in women these are almost wanting and the whole bone is more smooth and rounded. As age advances the medullary canal enlarges and encroaches upon the centre of the articular end, the cancellous tissue grows more open, and the trabeculæ become thinner and fewer in number.

The immediate cause is a fall upon the hand, but not, as usually described, outstretched. This may dislocate the elbow, or the shoulder, or it may break the surgical neck of the humerus; but it can hardly cause a transverse fracture through the radius. The hand is really almost under the body; the radius is much more vertical than horizontal; the wrist is violently over-extended; the lower fragment is fixed by the inferior radio-carpal ligament, and the cross-breaking strain snaps the bone in two. In men it occurs most frequently in falls from some considerable height, when they pitch upon their hands; or in accidents on the ice from the feet suddenly slipping up (I have known on a frosty morning, when the roads were very slippery, seven patients, one after the other, come to the hospital with this form of fracture). In women it comes from slighter falls, for not only is the bone relatively much weaker in proportion to their weight, but partly from their mode of dress, partly from their inability to save themselves, they come down upon their hand with much greater force.

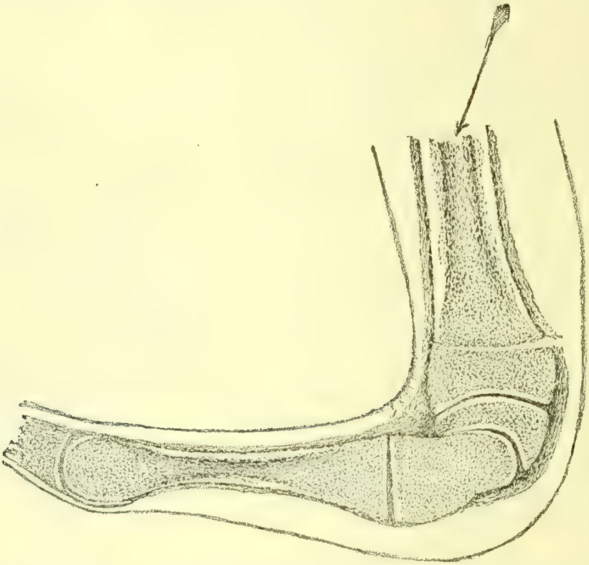

FIG. 119.—Section through the lower end of the radius, the carpus and metacarpus, to show the position in a fall upon the hand and the influence of the inferior radio-carpal ligament. If the force were continued, the hard compact anterior surface of the radius would be driven into the cancellous tissue of the lower fragment.

If the violence is only moderate in degree, the bone is merely broken across; if it is more severe there is impaction (in at least two-fifths of the cases and probably many more); the compact tissue of the dorsal surface of the upper fragment is driven into the cancellous tissue of the lower, without the periosteum on the back being torn; if the violence is greater still, there is comminution, the impaction being carried so far that the lower fragment is split into pieces.

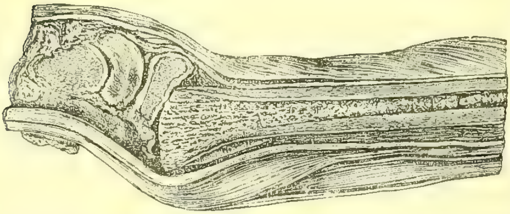

FIG. 120.—Section through forearm showing displacement in Colles' fracture.

Displacement.—The displacement is threefold: the upper fragment is held fixed by the pronators, the lower is carried bodily towards the dorsal surface, so that it no longer lies in the same plane; it is rotated round a transverse axis so that its articular surface, instead of looking almost directly forwards, looks forwards and upwards, and the outer side is, as a rule, displaced much more than the inner, partly because the latter is held by the triangular fibro-cartilage, partly because in falling upon the hand the radial side of the carpus receives the brunt of the shock. The original displacement is due, there can be little doubt, to the crushing force; but Colles himself attached much importance to the contraction of the extensor muscles of the thumb, which pass over the posterior surface of the radius in sheaths firmly connected to the bone.

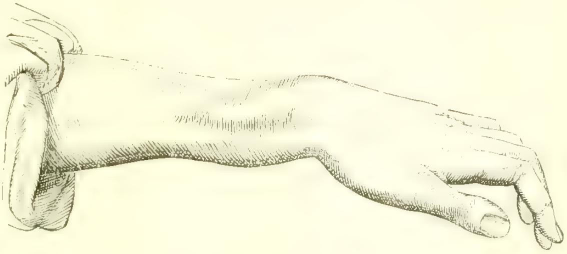
FIG. 121.—Outline of hand in Colles' fracture.

Symptoms.—If the bone is merely broken across, the deformity is not very marked, but if there is impaction or comminution, it is most conspicuous. Looked at from the radial side the back of the hand appears strangely long, the natural depression of the wrist seems to have disappeared, and in its place there is another an inch and a half or two inches higher up. Opposite this, on the flexor surface, the tendons are raised and thrust prominently towards the skin, while the wrist itself is unusually arched. Seen from above it is still more striking; the hand is displaced towards the radial side and abducted, the ulna stands out as if it were coming through, the fingers are flexed, pronation and supination are impossible, and the patient carefully supports the injured wrist in the palm of the other hand. Swelling sets in very soon. The flexor tendons are always hurt by being strained over the end of the bone, and their synovial sheath becomes filled with fluid at once; but this rather serves to exaggerate the deformity than to conceal it. The margin of the ulna can be traced down without any difficulty; and by firm pressure on the outer border of the radius, it is nearly always possible to make out the line of separation; but crepitus and undue mobility are rarely very distinct unless there is comminution.

Sprains of the flexor tendons of the wrist are sometimes mistaken for Colles' fracture; they are caused in the same way, and it is difficult to prove that the bone has escaped unhurt and that the tendons by themselves have been sufficiently strong to stand the strain.

The reduction of the deformity is often a matter of the greatest difficulty. Colles states, it is true, that a moderate degree of extension is sufficient to restore the limb to its natural shape, and that it slips back again at once; but this only occurs when there is comminution. Gordon, who denies impaction, and who describes the broken surface of the upper fragment as convex from within outwards, and also from before backwards, believes that the difficulty is entirely due to the rotation of the lower fragment; if the upper one is fixed, the lower pressed forwards, and the hand flexed to an angle of 45°, the concavity of the radius is restored at once. If there is no impaction, the obstacle must of course be due to locking of the fragments or muscular spasm; but there can be no question that it is present in a very large number of instances (probably the majority), and that the difficulty arises, partly from this, partly from the small size of the lower fragment, which makes direct extension almost impossible.

Direct manipulation of the fragments, while extension is being made from the hand, is very often successful. If this fails, adduction may be tried at the same time, the lower end of the ulna being used as the fixed point, and the forearm being held in a position of supination, with the elbow flexed; but care must be taken not to put too much strain upon the ligaments. If this does not succeed, another trial may be made at the end of a week, when the fragments have become softened to a certain extent; but it is not likely to be successful, and it is advisable to caution the patient from the first that there will probably be a certain amount of permanent deformity.

Treatment.—This depends upon the success with which reduction is accomplished. If the fragments cannot be separated, all that is required (so far as the fracture is concerned) is a simple wristlet, made of some light material, to protect the part from further injury. Union in these cases is very rapid, but it must not be forgotten that the flexor tendons are generally hurt at the same time, and that, unless steps are taken to prevent it, stiffness of the wrist and rigidity of the fingers are almost certain to follow.

If, on the other hand, the fracture is transverse without impaction, or if it is comminuted, and the deformity has really been reduced, the broken surfaces can be kept in contact with the simplest of contrivances. Either Carr's or Gordon's splint answers perfectly; but equally good results may be obtained by fixing the forearm midway between pronation and supination, in two straight wooden ones, reaching from the elbow to the bases of the metacarpal bones. After a week or ten days they may be replaced by a well-devised poroplastic gauntlet, including the thumb and the flexor surface of the forearm.

Adduction is of no use unless there is comminution; but then, in some instances, it is of great service. It is managed most easily by means of a pistol-shaped splint, arranged either on the dorsal or the palmar surface, with a short one on the opposite side for counter-pressure. The pads should be arranged as they are in Gordon's.

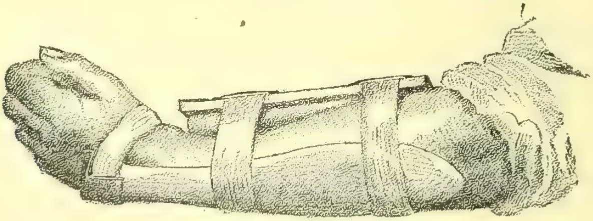

Fig. 122.—Gordon's splint applied.

Gordon's splint consists of a dorsal and a palmar portion: the former is much the longer, and is bent down at its lower extremity so as to maintain the wrist-joint in a position of semiflexion; the latter is very short, and is either carved or padded so as to fit into the concavity of the radius. If it is padded, the edge of the splint projects like a flange so as to avoid lateral pressure. It should be kept well up on the forearm, not allowed to encroach upon the wrist.

Carr's is simpler. The flexor splint is made of wood, and is about eleven inches long and two wide; across the end of this is a round bar, placed obliquely, so that when the fingers are flexed over it the hand is slightly adducted. It should be stoutly padded opposite the upper fragment on the radial side. A dorsal splint may be used with it, but in many cases it is not necessary.

Stiffness.—It is always necessary to warn patients that Colles' fracture is liable to be followed by stiffness, affecting both the fingers and the wrist, especially if there is any tendency to gout or rheumatism. It is due, in many cases, to strain of the flexor tendons; but it is made tenfold worse by rigid confinement, and it is by no means unlikely that, in certain circumstances, this is sufficient of itself. So far as the fingers are concerned, it can generally be avoided; they should never be bandaged; one great merit of Carr's splint is the freedom of movement it gives them; and passive motion must be commenced and thoroughly carried out from the first day. With the wrist it is more difficult, but on several occasions I have begun gentle manipulation on the fourth or fifth day with an excellent result. Pressure should be carefully applied along the forearm if there is much effusion into the sheath of the tendons; and as soon as the fracture is fairly firm, massage, counter-irritants, and steaming must be commenced; but not uncommonly it is necessary to place the patient under an anæsthetic, and work every joint thoroughly, before there is much improvement. If there is comminution of the lower fragment, or if the impaction is not reduced and the plane of the articular surface restored, some limitation of movement usually persists.

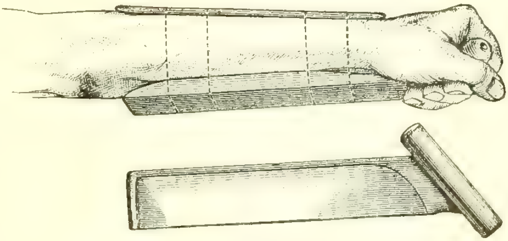

FIG. 123.—Carr's Splint.

Fracture of the lower end of the radius with palmar displacement is very rare, and does not present any special features. Separation of the lower epiphysis may occur; and, if union takes place by bone, the growth of the ulna may lead to serious distortion of the hand.

Compound and even comminuted fractures of the lower end of the radius may be produced by direct violence, without of necessity the joint being involved. In one case under my care, in which a man's wrist was pinned against the ground by the sharp edge of a beer-cask, though the bone was broken to pieces, the joint and both the arteries escaped unhurt.

FRACTURES OF THE ULNA

These may involve the olecranon, the coronoid process, or the shaft.

Fractures of the olecranon.—This process is frequently broken, especially in adults, in falls upon the point of the elbow; and it has been separated by muscular action. As a rule it gives way at its narrowest part, laying open the joint, but occasionally the tip only is detached, and then it is possible for the synovial membrane to escape. Stellate fractures are sometimes met with.

The amount of separation depends upon the extent to which the aponeurosis of the triceps and the fibres of the capsule at the side give way. If they are torn the upper fragment is raised by muscular contraction and the distension of the joint-cavity until there is a wide gap between them. More rarely the broken surfaces remain in contact, and crepitus can be obtained. Loss of extension is complete, manipulation and pressure are exceedingly painful, and the amount of swelling is generally very great.

Treatment.—If the bruising is severe, the arm should be laid upon a pillow for the first few days, in a position of easy extension; and cold and pressure applied until the swelling is in some measure reduced. In most instances, all that is necessary is a light wooden splint running down the front of the limb, sufficiently long to hold both arm and forearm firmly. It should be thickly padded opposite the joint, as absolute extension is uncomfortable, and has a tendency to tilt the surfaces. Sometimes the fragments can be brought closer together by a figure-of-eight bandage, or by loops of strapping, so arranged as to pull the upper one downwards; but in many instances this seriously increases the swelling of the limb. It is more satisfactory to bandage the part carefully and evenly with abundance of wool around the joint, so as to ensure early absorption of the fluid and thorough relaxation of the muscles. This position should be maintained for three weeks, and then the arm may be gradually bent, until in about ten days the forearm rests easily in a sling. If there is much separation, union is nearly sure to be fibrous; but so long as it is fairly close and strong it does not interfere with the use of the limb. Stellate fractures unite by bone. Flexion from the first has been recommended by some, on the ground that if ankylosis were to occur the arm would be in a more convenient position; but there is scarcely any reason to fear this (fig. 124).

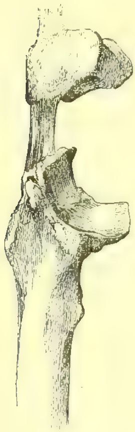

Fig. 124.—Fracture of olecranon with fibrous union.

If union fails, or is so weak that there is no power of extension, the fragments must be drilled and wired together. I have seen one instance in which the use of the triceps was lost, owing to the upper portion becoming united to the humerus.

Compound fracture is not uncommon. If it is merely transverse, the fragments should be fastened together at once; if there is comminution, every effort must be made to save the part; but if there is any fear of suppuration, it is better to perform excision.

Fracture of the coronoid process is a very rare form of accident, and is nearly always associated with backward dislocation of the bones of the forearm. It may be produced by direct violence crushing the bone, or by falls upon the hand when the elbow is extended; the shock must be transmitted from the radius to the ulna, and from this to the trochlear surface of the humerus. The tip also may be detached by violent abduction, or adduction, of the forearm. The brachialis anticus is attached to its anterior surface, near the base, so that fracture from muscular action alone can hardly take place, and separation of the tip from this cause is impossible. The most important symptom is the displacement backwards of the bones of the forearm, when the elbow-joint is extended, returning as soon as the reducing force is relaxed. In addition, there is intense pain on pressure, increased by attempts at flexion, and, unless it is merely the tip, there is a considerable amount of swelling. It is recommended to keep the elbow-joint flexed at a little less than a right angle, secured by plaster or a fixed bandage, and commence passive motion at the end of a week. If the fragments are at all separated, union is sure to be ligamentous.

Fracture of the shaft of the ulna by itself is usually the result of direct violence, and, because of the exposed situation of the bone, is often compound. It may give way at any part, but owing to its comparative weakness it is more common below the middle. The line of separation is usually distinct, unless the amount of bruising is too great, and the movements of the arm are restricted and very painful. The displacement is not conspicuous, unless the radius is broken or dislocated at the same time.

If there is any tendency for the ends to be displaced outwards towards the radius, the fracture should be put up as if both bones were broken. In other cases, a shield of gutta-percha, long enough to grasp the whole of the forearm and the ulnar side of the hand, is quite sufficient. As the hand, when placed in a sling, rests upon the ulnar border, care must be taken that the fragments are not displaced by direct pressure.

Fracture of the styloid process of the ulna is not uncommon when the lower end of the radius is broken and the hand much abducted. Union is usually fibrous.

Fracture of the radius and ulna, together, in the middle of the forearm may occur from direct violence, or from a fall upon the hand. In children the fracture is often partial or greenstick; and the only prominent sign is an angular deformity, generally an exaggeration of the normal curve. When the separation is complete, crepitus and undue mobility are present. Pain, swelling, and loss of power occur in all alike.

Greenstick fractures must be straightened as far as possible; sometimes this cannot be done without making them complete; but if there is only a small angle, not sufficient to interfere with pronation and supination, it disappears to a great extent as the child grows older. When the injury is above the level of the pronator radii teres, the forearm should be put up in the position of complete supination, as already described in speaking of fracture of the shaft of the radius alone. When it is lower down, two straight splints should be used, wider than the limb, and thoroughly well padded, especially down the centre, so as to avoid as far as possible any risk of cross union; and the fracture should be set with the limb midway between pronation and supination, that is, with the thumb upwards and the dorsum of the hand forwards. Passive motion should be commenced in about three weeks, as there is some risk of the interosseous membrane becoming thickened in the region of the fracture and losing its flexibility. No bandage should ever be applied under the splints, and care must be taken to examine the fracture every day for at least the first week. It is in this form of injury that gangrene is especially common, to some extent as already mentioned from flexion of the elbow, but also because both radial and ulnar arteries are easily compressed against the bones for a considerable portion of their course.

FRACTURES OF THE CARPUS AND METACARPUS

Fracture of the carpus is not common owing to the mobility and protected position of the bones, and to the way in which the pressure is distributed among them. They may give way, however, from direct violence; exact diagnosis, unless the injury is compound, can rarely be obtained, especially as the amount of bruising is always extensive. As a rule it is sufficient to carry the hand in a sling, and for the first few days to protect the part from careless movements by means of a light palmar splint of gutta-percha, recollecting that the natural position for the joint is one of slight extension. Unless there is comminution or fear of suppuration, passive motion should be commenced as early as possible, so as to avoid permanent rigidity.

The metacarpal bones are often broken from direct blows, as in fighting ; the first from its exposed situation giving way the most frequently ; the third the least. The displacement is nearly always towards the dorsum of the hand, an exaggeration of the natural curve, so that the head is turned to the palm. If seen at once, it can easily be rectified by direct manipulation ; but often the patient does not apply for some days, considering it a mere bruise. The plan recommended by Astley Cooper, of placing a ball in the palm of the hand, and extending the finger over it, answers very well, and maintains thoroughly the natural curve ; but, as a rule, a simple gutta-percha splint, well moulded, is quite sufficient, and is much less cumbersome. The metacarpal bone of the thumb is liable to a peculiar form of fracture which can easily be mistaken for dislocation, as it does not involve the dorsal surface of the bone. The palmar half of the base is broken off ; the length of the bone is unaltered, but the security of the articulation with the trapezium is lost, and the bone keeps constantly slipping back. Crepitus can be felt by pressing the detached fragment from the palm outwards towards the rest of the bone. Union is generally attended with some impairment of movement.

Simple fracture of the phalanges is very common, and may be treated either with a light pasteboard splint or a gutta-percha trough, keeping the finger nearly extended.

Compound fractures extending into the wrist-joint are very serious ; the bones are generally crushed, the joints torn open, and often the soft parts extensively injured as well. The question of amputation must be decided by the last-mentioned consideration : I have on several occasions treated fractures of this description, in which it was necessary to remove fragments of bone from both rows of the carpus, with corrosive sublimate baths for an hour each day, not only without suppuration, but with an excellent result so far as movement was concerned. If inflammation and suppuration once set in, the whole carpus is almost sure to become involved, the bones undergo necrosis, and the pus is very likely to spread from the articulations, either into the synovial sheaths of the tendons, or into the deeper planes of cellular-tissue, until the whole limb is implicated. If this subsides, the hand and wrist are almost useless ; more often than not amputation is required to prevent more serious consequences.

Compound fractures of the hand, if they are at all extensive, if for example the palm or several fingers are badly crushed, should be treated in the same way. It is often impossible to tell at the first how much of the bruised and damaged tissue will live, and every fragment is of importance. The sloughs, it is true, are somewhat slow in separating, but, owing to the amount of the antiseptic dead tissues absorb, putrefaction does not take place ; there is no fear of cellulitis or other inflammatory complications ; granulations gradually spring up, and the whole of the tissue that is not too much damaged by the accident is preserved.

FRACTURE OF THE PELVIS

The innominate bone may be broken by direct violence or by muscular ction ; or the pelvic girdle may be squeezed until it gives way under the ressure. In this case the position and direction of the fracture are often lefinite ; under other circumstances they are very variable.

Fractures of the False Pelvis

Portions of the crest of the ilium are occasionally broken off by direct lows ; in a few rare instances the anterior superior spine has been detached y muscular action ; and the same thing has been known to occur in the ase of the epiphysis that forms the crest ; but unless there is great com- ninution, injuries of the false pelvis are rarely attended by serious conse- uences ; the shock may be severe ; the ordinary signs of fracture are well narked ; but the viscera very seldom suffer ; and repair takes place readily, hough there is often a certain amount of difficulty about retaining the ragments in proper position.

Fracture of the Acetabulum

This may be produced in two ways : in the first and the most serious, he head of the femur is driven inwards with such violence that it splits the avity into pieces ; in the second a portion of the lip only is detached. The ormer of these never occurs except as the result of extreme violence applied o the great trochanter ; the bone is very much comminuted (the three ortions that form the acetabulum being driven asunder) the shock extreme, nd the danger of injury to the viscera very great.

The position the limb assumes closely resembles that of fracture of the eck of the femur, but the trochanter is more sunken. The amount of nobility varies a good deal ; in many instances it is unusually free, probably wing to the small relative size of the neck compared with the head ; crepitus s generally distinct, and manipulation exceedingly painful. If there is any loubt, an attempt may be made to feel the head of the bone through the ectum or vagina. The accident frequently proves fatal from shock or from njury to the viscera ; if the patient rallies sufficiently, an attempt must be nade to extract the bone, but it is not very likely to succeed ; if it does the imb must be put up as in fracture through the base of the neck. Movement s sure to be much impaired.

Fracture of the lip of the acetabulum is more common. It is caused y the sudden impact of the head of the femur against the upper and back art of the cup, and may be produced by falls upon the feet. In one instance, owever, under my own observation, it was clearly shown that the upper art of the body struck the ground first, so that in all probability it was roduced in the same way as the fracture that is met with at the base of the kull from the sudden shock of the atlas coming upon the occipital condyles ith the weight of the body behind it. The position the limb assumes is lmost identical with that of dislocation backwards ; reduction is easy, but s soon as the hand is removed the head of the bone slips back. Crepitus an generally be felt if deep-seated pressure is applied above and behind e great trochanter while extension is being made. This injury must be treated in the same way as fracture through the base of the neck of the femur. The patient is to be kept in bed with a long splint, and weight-extension, proportionate to the strength of the muscles, for at least three weeks. After this a permanent appliance is to be worn for six weeks, or two months more; the foot must be slung, and no weight allowed to rest upon the limb until at least this length of time has elapsed, though passive motion may be commenced much earlier. In most cases there is a certain amount of shortening afterwards, but the use of the limb is not impaired.

Fracture of the Sacrum and Coccyx

The sacrum is occasionally, but very rarely, broken by direct violence. The lower portion suffers more frequently than the rest, owing partly to its weaker construction. If the fracture is compound, as it often is, it must not be forgotten that the spinal canal runs down the middle of the bone, and that meningitis may occur. When there is great comminution, the structures on the anterior surface, in particular the nerves as they issue from the foramina, may be involved as well.

The coccyx, on the other hand, is frequently injured by falls in a sitting position upon something hard, or by kicks. Sometimes it is broken right across and displaced, so that crepitus can be distinctly felt when it is grasped between two fingers, one in the rectum, the other on the skin, and moved backwards and forwards; more often it is only bent or partially broken. Perhaps, sometimes, the injury is really a dislocation. The most prominent symptom is the pain caused when any of the muscles attached to the bone are called upon to act; sitting, stooping, walking, coughing, and especially defæcation are attended with much suffering. The displacement is easily reduced, but is very liable to return. The only treatment is to keep the patient in the recumbent position for a few days until the pain has to a certain measure subsided, and to keep the motions relaxed so as to avoid, as far as possible, any undue strain upon the sphincter or the levator ani.

Injuries of the coccyx are very frequently followed by persistent pain, and great tenderness of skin over the region supplied by the lower sacral nerves. This is especially the case in women, though it is not confined to them. Sometimes it can be traced to gouty or rheumatic inflammation of the fibrous tissue surrounding the bone, and it may be relieved by iodide of potash, and by counter-irritants; but in many instances it is rather a sign of uterine derangement, and nearly always it becomes worse at each menstrual period. In the worst cases it is necessary to provide the sufferer with a circular cushion, so that the tuberosities of the ischium may sustain the whole weight, and the coccyx lie, as it were, buried. Subcutaneous section of the tissues around the bone and excision of the bone itself have been performed, when the distress was very great, but not always with success.

Fractures through the Pelvic Girdle

When the pelvis is crushed it gives way at the weakest spot, rather than at the sides of the circle; the line of fracture nearly always passes across the bone at the inner margin of the obturator foramen, and then if the force continues, at or near the sacro-iliac synchondrosis on the opposite side. Sometimes, when the force comes from in front, the fracture is almost symmetrical, the whole of the body of the pubes being separated from the rest, and both the articulations opened up behind. In a few cases the displacement is perceptible at once; more often the existence of a fracture is only suspected from the extreme shock, the intense pain at certain points, greatly aggravated by any attempts to separate or bring together the crests of the ilium, and the injury to the neighbouring viscera. The urethra suffers most often; it may give way either on the superficial or the deep surface of the triangular ligament; in the former case the urine is extravasated into the scrotum, in the latter into the deep cellular tissue of the pelvis. The bladder, however, may be ruptured, the rectum, or even the contents of the abdomen severely injured, and the large vessels torn across. The injury, even when it is not complicated in any way, is always serious; and as the soft parts and the viscera are generally torn, crushed, or wounded by splinters, the prognosis in accidents of this kind is most unfavourable. So far as the fracture itself is concerned, very little is required; the part must be kept at perfect rest and over-examination carefully avoided, but the condition of the viscera must be ascertained with the least possible delay.

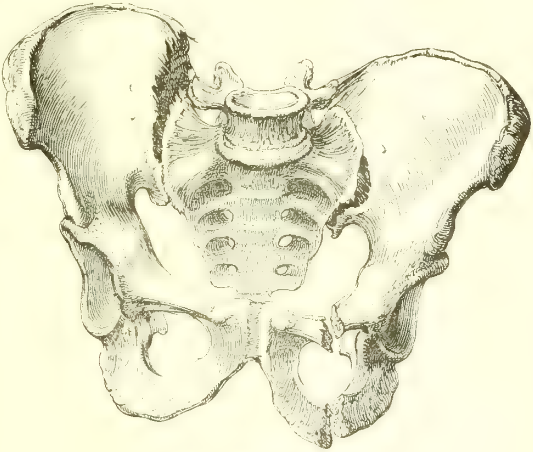
Fig. 125.—Fracture of pelvis.

FRACTURES OF THE FEMUR

I. The Upper Extremity

These were divided by Sir Astley Cooper into (1) fractures of the neck entirely within the capsule, (2) fractures at the base of the neck where it oins the trochanters, external to the capsule, and (3) fractures through the trochanter major, to which may be added (4) separation of the epiphyses. As, however, wholly extracapsular fracture of the neck of the femur is an anatomical impossibility, so far, at least, as the front of the bone is concerned; and as this does not take into consideration the question of impaction (on which epair depends to a very great extent), it seems better to divide them into:

(1) Impacted fracture.
(2) Non-impacted fracture, of which there are two varieties:
  (a) Intra-articular, wholly within the joint; and
  (b) Through the line of attachment of the capsule, at the base of the neck, partly within, partly without.
(3) Fracture through the trochanter.
(4) Separation of epiphyses.

It is true that a certain number of cases cannot be grouped under any one of these, but it holds good for the vast majority. They are to be regarded as types of common occurrence, presenting perfectly definite symptoms, and requiring entirely different methods of treatment.

It is as well to leave impacted fractures until the other forms have been considered.

Intra-articular fracture

This is peculiar for several reasons: it is very rare under fifty years of age, very common afterwards; it is produced by exceedingly slight degrees of violence; it is more common in women than in men; and unless it is impacted, or the fragments are in some way held together, bony union never takes place. The line of separation lies wholly within the capsule, immediately below the head. If the force acts vertically the fracture is stated to be generally oblique; if from in front, transverse. Occasionally the under surface only gives way, the tissue at the upper part of the neck being bent rather than broken. When it is impacted the compact tissue on the under surface of the neck is driven into the cancellous substance of the head.

This may be explained in great measure by the structure of the part and by the changes the bone undergoes as age advances.

The angle which the neck of the femur forms with the shaft is commonly stated to be about 128° in the adult, and to diminish gradually in old age; in women it is less than in men, and certainly the smaller it becomes and the more nearer it approaches a right angle, the more likely it is to give way. It is not true, however, that this change is invariably associated with age. In many old people the angle of the femur is quite unaltered; and on the other hand, in examining the bodies of well-developed adults, without a sign of rheumatoid arthritis, I have on several occasions found the top of the trochanter higher than the head, and this rotated so far that a flattened facet was developed on the front surface, corresponding to the tendon of the iliopsoas.

The changes in the substance of the bone are more constant, but even they are proportionate rather to the amount of disuse than to the years of the patient. The cavity of the shaft extends upwards with the cancellous tissue of the neck; the trabeculæ are thinner and softer, the bone itself is infiltrated with fat, and the compact layers on the exterior waste, until, in extreme cases, they are almost translucent. When this is far advanced it is scarcely surprising that a very slight strain is sufficient to break it across.

The causes are always of the most trivial description. Sometimes it is a sudden vertical shock, as in slipping from off a curb-stone; in other cases it is a twist, as when in walking the inner side of the great toe catches against a fold of the carpet: the ilio-femoral band acts as the fulcrum of a lever; the leg is the long arm, the neck the short one; the head of the bone cannot move, the ligament is much too strong to yield; so if the force is severe and sudden enough the short arm must break across at its weakest spot. Even turning round in bed will sometimes do it. In a third set, the bone is broken by a fall upon the trochanter and then there is often impaction; the thinnest part of the neck gives way, and a continuance of the force drives the compact tissue upwards and inwards into the cancellous substance of the head.

Signs.—No attempt should ever be made to elicit crepitus, and manipulation of all kinds should be avoided as much as possible. The fragments at first are close together, and the only hope in obtaining union lies in keeping them there; any movement that would cause crepitus is sure to separate them.

Displacement.—The direction is nearly always the same, but the extent is very variable. The neck of the femur is invested, especially on its under surface, by dense bands of fibrous tissue, which pass upwards from the line of attachment of the capsule to the margin of the head. These are the reflected fibres which form a kind of periosteum for the neck and convey to the head its most important vessels. In intra-articular fracture they rarely give way at the time of the accident, and partly from this, partly because the capsule is not torn, much separation of the fragments is unusual. The muscles that pass from the trunk to the thigh pull the femur upwards and inwards towards the middle line, so that the trochanter sinks in and the limb is slightly shortened, but the amount of this rarely exceeds three-quarters of an inch. After two or three days, however, when, owing to the exudation that takes place, all the fibrous tissue is infiltrated and softened, it often increases to an inch and a half, or even two inches, unless care is taken to prevent it.

As accuracy in measurement is very essential, various methods have been devised for estimating the amount of alteration. Whichever plan is adopted care must be taken that the position of the two limbs is absolutely symmetrical; the least deviation is sufficient to vitiate the result completely. A rough guess may be made by comparing the position of the two malleoli, having first made sure that the body is perfectly straight, and that the pelvis is not tilted. Measurement, either by means of tape, or better with a sliding graduated rod, from the anterior superior spine of each side to the internal malleolus, is more accurate; but neither of these methods can prove where the shortening is. To effect this three different plans have been recommended: Nélaton's line, Bryant's triangle (fig. 126), and Morris' bitrochanteric measurement.

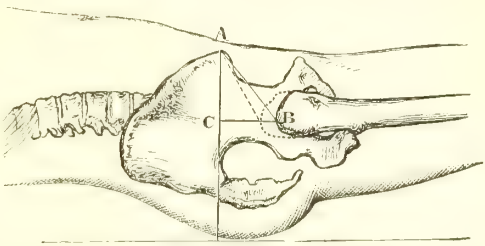

Fig. 126.—Bryant's triangle. C B, test-line for racture or shortening of the neck of the thigh-bone.

Nélaton's test consists in stretching a tape from the anterior superior spine of the ilium to the most prominent part of the tuberosity of the ischium. In the healthy adult the top of the trochanter never comes above this; if it does, the neck of the bone must have been shortened either by disease (rheumatoid arthritis or rickets) or by fracture. Bryant's triangle is made up of the perpendicular line from the anterior superior spine (when the patient is lying down); the line from the same point to the great trochanter; and a third drawn from this at right angles to the vertical one. The difference in the length of this third line on the two sides gives the amount of shortening. Morris' bitrochanteric measurement compares the distance on each side from the median line to the top of the great trochanter. It indicates the inward displacement of the trochanter, and can only be taken satisfactorily by having a rod, graduated on each side from the middle, with two pointers sliding on it, so that when it is held over the body they may come into contact with the top of the great trochanter.

The appearance of the limb is very characteristic. It lies on its outer side, completely everted from the hip to the foot, with the knee slightly flexed; there may be a slight swelling in front, over the hip-joint, due to the rotation of the lower fragment; the trochanter is sunken inwards and drawn nearer the anterior spine, and there is from half an inch to an inch of shortening. There is no superficial bruising or contusion ; the trochanter is not thickened, and though it is painful when pressed upon, the pain is not like that of fracture through the base of the neck. The most tender spot is generally on the inner side of the thigh, about the insertion of the iliopsoas, or a little lower down. In some rare cases the patient is able to raise the heel from the bed, probably because the reflected fibres are intact, or the fragments interlocked; more often the knee can be flexed a little, but any attempt to lift the leg fails completely. In a few exceptional cases, there has been inversion of the foot. The eversion is due mainly to the weight of the limb; at least there is no doubt this is sufficient to cause it, though possibly the contraction of the iliopsoas may assist (the short muscles attached to the great trochanter when the neck is broken would scarcely have any rotatory power); inversion, when it is present, must be produced by the direction of the violence that caused the fracture, and is probably kept up by the accidental locking of the fragments. In most cases the fascia lata on the outer side of the thigh, extending from the crest of the ilium to the head of the tibia, is distinctly relaxed, both above the trochanter and again above the knee-joint.

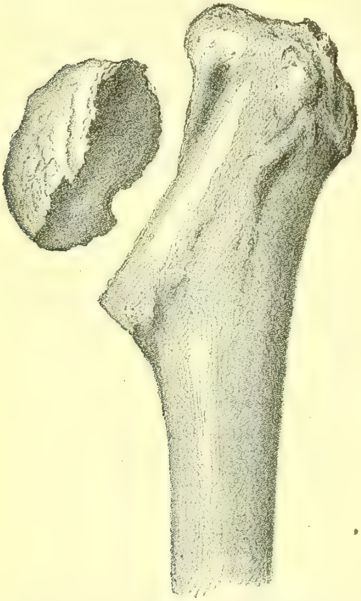

FIG. 127.—Intra-articular fracture of neck of left femur. No union has taken place; the neck has been absorbed; and the under part of the head glides up and down a polished surface corresponding to the anterior intertrochanteric line.

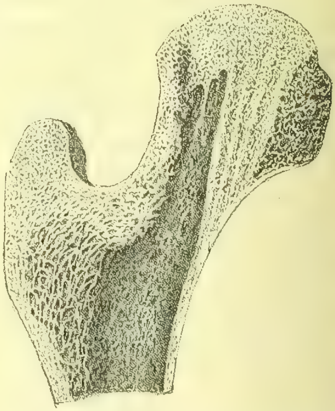

FIG. 128.—Vertical section through upper end of right femur from the same patient, showing the changes undergone in extreme atrophy.

Manipulation should be avoided as much as possible, but when it is really necessary for the diagnosis, extension readily restores the limb to its proper length, and often at the same time gives rise to the sensation of crepitus, especially if the limb is rotated inwards at the same time. Further, if the trochanter is grasped while this is being done, it clearly does not move through the same range as the other. Movement in all directions is abnormally free, and very painful.

The constitutional disturbance in these cases is always slight at first; there is no fever and but little shock, but very often the patient never really rallies, the circulation remains feeble, the heart's action never recovers, the mind begins to wander, and congestion of the lungs, retention of urine and cystitis, or bed-sores, make their appearance in spite of every care. The prognosis therefore is always serious, especially in the aged.

Repair.—Union by bone probably never occurs unless the fracture is impacted. The broken surfaces are not in contact. Even if the action of the muscles and the weight of the part could be set aside, the distension of the capsule, partly from hæmorrhage, partly from exudation, would be enough. Further, the head is often rotated in its socket, so that it no longer faces the broken surface of the neck; and as its blood-supply is cut off, no callus is ever found on the upper fragment. As Astley Cooper pointed out, most of the vessels that supply this part of the bone enter the neck on its under surface, and of course are torn; recently too it has been shown that the artery running in the ligamentum teres does not enter the bone at all. The blood-vessels in the neck probably dilate, because, in a large proportion of cases, this part of the bone is completely absorbed. The main bond of union is the capsule, which becomes enormously thick. Sometimes there is a certain amount of fibrous tissue formed between the fragments, passing from the under surface of the neck, and also from its cancellated structure, to the head; but in many there is no union at all, the surfaces become hard and polished, the neck disappears, and the head of the bone rests on the lesser trochanter, or spurs are thrown out round the base of the neck to catch the rim of the acetabulum. Many patients after accidents of this kind remain almost bedridden, or can only get about with assistance; others, especially if they are not corpulent, can leave aside their crutches after a time and walk with a stick—a few can dispense even with this; but, in spite of a high heel to compensate for the shortening, a certain amount of lameness is always left.

Treatment.—This must be guided entirely by the condition of the patient. Many old people never really lie down at all, and to keep them on their back by means of a long splint would inevitably bring on congestion of the lungs. Astley Cooper recommended that they should be propped up in bed, with the limb supported by pillows in the most comfortable position, for ten days or a fortnight, until the pain in some measure had subsided; then they should sit up every day in a high chair, so as to avoid flexion of the limb, and begin to use crutches as soon as possible, bearing a little more weight upon the foot each day, until the capsule had become sufficiently strengthened. In the mean time water-cushions must be used freely so as to avoid the occurrence of bed-sores; the most scrupulous cleanliness must be observed, especially as urinary trouble, partly from age, partly from the confinement in bed, is very common; and the skin must be sponged with spirit every day to harden it. As soon as the patient begins to sit up, the limb must be enclosed in a shield made of leather or felt, large enough to grasp the pelvis and the thigh, running completely round the body and two-thirds round the limb, as low as the knee. This should be made with straps and buckles, so that, while it is able to hold the part firmly and give it sufficient support to protect it from injury, it may also be removed every few days for the purpose of attending to the skin.

In younger patients, especially when the amount of separation is not great, an attempt may be made to procure union between the fragments, though it is very unlikely that it will be osseous. A long splint must be applied to the outer side of the limb from the axilla to below the foot, as in fractures of the shaft, and a moderate weight attached to the leg, counter-extension being made by raising the foot of the bed. Particular care must be taken to correct the eversion ; it is not sufficient for the foot to be merely straight, the great toe must be a little inverted, or when the bandages are removed it will be found that the correction is not sufficient. If possible this must be kept up for six weeks, though if the patient's health begins to fail, or, if in spite of water-cushions, there is any fear of bedsores, it is possible to do with a fortnight less ; then the limb may be secured either in a Thomas's hip-splint or in a leather shield, and the patient allowed up on crutches, the foot being slung, and not allowed to touch the ground for six weeks or two months more. Unless rheumatoid arthritis sets in, there is very little fear of the hip-joint becoming unduly stiff.

In one or two instances the hip-joint has been laid open from in front and the fragments wired together. The operation was successful and apparently osseous union followed ; but cases in which such a proceeding could be recommended must be very rare.

Fracture through the base of the neck

This stands out in clear contrast to the former. The line of separation follows the intertrochanteric line in front ; behind it is a little internal to it, so that the fracture is partly within, partly without the capsule : the whole of the neck is detached and the trochanter often comminuted. It may occur at any time, but is most common in adult life, and in men, because it is never caused but by an extreme degree of violence applied directly to the hip. A moderate amount of force breaks the bone across, drives one fragment into another, and leaves it impacted there; when it is more severe the wedge-shape neck splits the trochanter into pieces and frees itself again. There is a great deal of bruising all round the hip; the trochanter is widened, and often the fragments are quite loose; crepitus is always present; pain is very great; usually the shock is severe, sometimes even fatal; and the amount of shortening at the first is rarely under an inch and a half, and may be as much as three. Eversion is present in the vast majority, but occasionally inversion occurs, as it does in the intra-articular form.

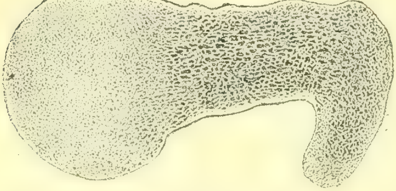

FIG. 129.—Horizontal section through neck and trochanter of femur to illustrate the method of production of fracture through the base of the neck. The anterior layer of compact tissue bends when the posterior is driven into the trochanter, and then breaks. Probably partial fractures are of common occurrence.

Bigelow has shown, in reference to these injuries, the way in which the fracture occurs. If a horizontal section is made through the neck and head of the femur, the anterior layer of compact tissue is seen to be equally strong throughout, perhaps rather stronger in the middle than elsewhere, owing to the section passing through the tubercle ; the posterior, on the other hand, ends abruptly in the cancellous tissue of the trochanter. In a fall upon the hip, this part gives way first ; the anterior layer splits more or less vertically, so that the shaft is everted upon the neck ; and if the force continues, the posterior compact layer is driven farther and farther into the trochanter until it splits it into fragments.

The difference in the mode of repair is equally striking. Union by bone is almost invariable, and the amount of callus thrown out is often greatly in excess of what is needed. In these cases therefore every effort must be made to restore the length of the limb, and the position of the fragments, as thoroughly as possible. Very often it is of great advantage to give the patient an anæsthetic ; the manipulation is painless ; the broken surfaces can be adjusted more accurately ; the muscles are relaxed so that the limb can be extended to its full length at once ; and when consciousness returns, owing to the compression and extension to which they are subjected, there is not the same amount of spasmodic contraction. The most efficient method is by means of a long splint and a weight, the amount employed being regulated in each case by the condition of the muscles and the degree of shortening. If it is attached to the limb alone, and there is no friction against the bed-clothes, eight or ten pounds are usually sufficient, though in exceptional cases much more may be required. The rapidity with which repair takes place depends upon the age of the patient and on the bruising and comminution to which the parts have been subjected. Generally the patient may be allowed to get about at the end of four weeks with a Thomas's hip-splint, or a leather shield, or a firm spica (made extra strong in front and on the outer side), but no weight can be allowed upon the limb for at least six weeks or two months more. Union rarely fails, but there is nearly always a certain degree of lameness and shortening afterwards.

Impacted fracture of the upper end of the femur

This again is entirely different. There are two varieties, corresponding to the two described already, but they can rarely be distinguished from each other ; and, as they require precisely the same treatment, it is doubtful if there is much advantage in attempting to do so. In the one the line of separation follows the base of the neck, and this is forced into the substance of the trochanter until it is fixed there (fig. 130) ; in the other the fracture is immediately below the cartilage, and the under surface of the neck is driven into the

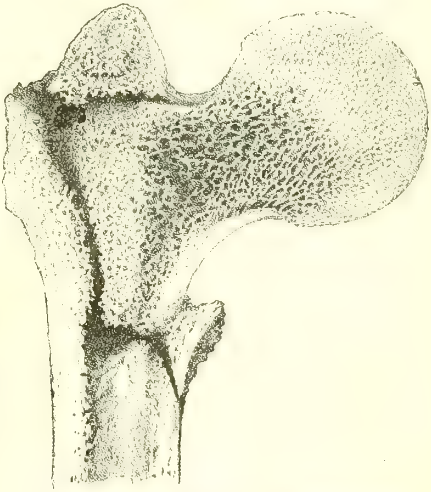

FIG. 130.—Impacted fracture through base of neck of femur.

cancellous tissue of the head (fig. 131). The former is not confined to any age, and sometimes may be diagnosed from the condition of the trochanter; the latter (the intra-articular form) rarely occurs except in old people, but it is seldom possible to distinguish one from the other. The important feature is the existence of impaction.

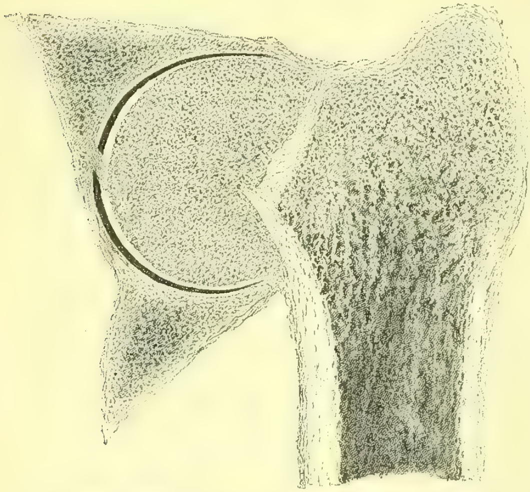
FIG. 131.—Impacted intra-articular fracture of neck of femur.

The cause is always direct violence, a fall or a blow upon the hip. The symptoms are almost the same as those described already, but they are not nearly so marked. The shortening is rarely more than half, or at the most three-quarters of an inch; and so long as the impaction continues it does not vary. There may be inversion in this as in the other fractures, but it is very rare; the limb is either straight or everted, and it is not possible to rotate it inwards, as it is when the bone is not impacted. Sometimes the patient can lift the limb from the bed; walking even is possible; and Astley Cooper mentions the case of a man who went about for four days and passed inspection before the impaction gave way. Crepitus and undue mobility of course are wanting; while the amount of pain and the severity of the shock naturally vary with the nature of the accident. The condition of the fascia lata on the outer side of the thigh, whether it is relaxed or not, is in many cases the only sign by which it is possible to distinguish between impacted fracture of the neck of the femur and a severe contusion of the hip in an old or rheumatic patient. Sometimes even this fails, and then the diagnosis can only be made by the length of time that it takes for the limb to recover.

The important point in these fractures is the presence of impaction. If this can be preserved, repair by bone is fairly certain, with the minimum of deformity; if it is broken down, in the one case there will be only ligamentous union, perhaps none at all; in the other the deformity and shortening will almost certainly be increased, and the period of confinement much lengthened. The limb must be handled with the utmost care, and any manipulation that is not absolutely necessary strictly avoided. For security's sake it should be bandaged to a long splint, or if there is any fear of congestion of the lungs, fixed between sand-bags with a weight of two or three pounds attached, not for the purpose of keeping up extension, but merely to prevent spasmodic contraction. In three or four weeks' time a Thomas' splint may be applied; or the limb encased in a shield or a spica; and the patient allowed to get about on crutches with the foot suspended in a sling. A shorter time than this is rarely advisable: and if the injury is very severe, or the patient corpulent, it may be extended with advantage.

The accident is a serious one, the weight and the leverage of the limb are very great; and it is rarely worth while running any risk. The shortening is easily compensated for, but if much eversion of the limb is left the position of the foot is very awkward.

Fracture through the trochanter

Two forms of this have been described, but they are both rare. The first is merely a variety of the fracture through the base of the neck without impaction, the line of separation running obliquely through the trochanter a little farther outwards, so that one half remains attached to the head and neck, the other to the shaft. The symptoms depend upon the amount of displacement, which, unless the fragments become locked in some way, is generally very great. In one case the injury closely simulated dislocation on to the sciatic notch, but the presence of crepitus and undue mobility, the results of measurement in the flexed position of the limb, and the absence of the hollow in Scarpa's triangle, are sufficiently characteristic to prevent serious difficulty.

In the other variety the trochanter is detached from the rest of the bone by direct violence. Several instances are on record, but, as the patients were young, in all probability they were examples of separation of the epiphysis (fig. 132). The swelling and ecchymosis may be so great as to render diagnosis difficult; passive movement of the joint is unimpaired, though very painful; crepitus can rarely be felt, owing to the way in which the trochanter is pulled upwards by the glutæi and the short rotators, and the length of the limb is unaltered. In one case the broken surfaces were held together by the fascia, which was not torn. Union, unless this is preserved, is almost sure to be fibrous, and for some time at least there is considerable loss of power over the limb.

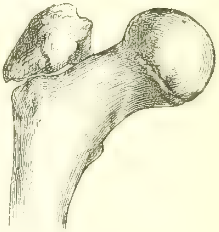

Fig. 132.—Separation of great trochanter of femur.

Separation of the epiphysis forming the head of the femur may occur, but it has not been proved. The symptoms would be the same as those of the intra-articular variety.

Diagnosis.—The diagnosis of fracture of the neck of the femur must be made from sciatic dislocation, impaction of the head of the bone into the floor of the acetabulum, fracture of the lip of the acetabulum, and contusion, especially in cases of rheumatoid arthritis. If there is the least doubt, the examination should be completed under an anæsthetic; to say nothing of the pain, it is almost impossible to manipulate the thigh of a muscular adult satisfactorily unless the muscles are relaxed.

1. *Sciatic dislocation.*—The difficulty is due to the fact that in this form of injury the limb is often almost straight, and retains (especially at first) a very unusual degree of mobility; and also that the head of the bone can rarely be felt. Unless, however, the patient is very stout, an empty space can always be made out in Scarpa's triangle; the femoral vessels can be felt to dip down suddenly; abduction of the limb, when it is flexed at a right angle, is impossible, and the measurement of the length of the thigh, when the hip is in this position, shows very considerable shortening.

2. *Impaction into the floor of the acetabulum.*—This is a very rare accident, but on several occasions the mistake has occurred. The injury is pro-

duced in the same way; the violence is extreme and the amount of bruising sufficient to conceal everything. Movement may be very free, probably owing to the extent to which the bone gives way. The chief distinction is the extreme inward displacement of the trochanter; in addition there may be signs of injury to the innominate bone; and it may be possible to feel the head of the femur through the rectum or vagina.

3. *Fracture of the lip of the acetabulum.*—When the upper and back part is chipped off, the head of the bone slips out of the cavity, and rests on the dorsum, almost in the position of a dislocation. In one case under my care the displacement was exactly that of a sciatic dislocation, and was reduced as such, but it immediately returned, and when the limb was manipulated the head of the bone could be easily felt above and behind the trochanter.

4. *Severe contusions.*—In these the difficulty is very much greater, and if the limb is shortened and everted from old rheumatoid arthritis; if (as is often the case) the trochanter is thickened, and, owing to the disappearance of the articular cartilage, there is a certain amount of crepitus on movement, it may be impossible to feel certain until a sufficient length of time has elapsed for the muscles to recover. The limb lies perfectly helpless and everted; the muscles cannot act owing to the way in which they have been bruised, and it is impossible to say whether the whole of the shock has been expended on the soft tissues, or if the bone has suffered too. Not improbably in many of these cases the neck is splintered on its anterior surface, though it may not actually be broken across. The history is of little service, supposing it could be relied upon; the existence of rheumatoid arthritis would not in any way preclude fracture. The only distinguishing sign is the condition of the fascia lata on the outer side of the thigh; if the shortening is gradual (as from disease) this is tense; if sudden, it must be relaxed; but it must be admitted that it is not always possible, even when the two sides are compared, to make certain of the difference.

At a later period the diagnosis of contusion without fracture is occasionally called in question, owing to a peculiar alteration that takes place in the substance of the bone. It sometimes happens that, within a twelvemonth of an accident of this kind, the neck of the femur almost disappears, the limb becomes everted and shortened an inch or even an inch and a half, the muscles waste, the movements are crippled, and the appearance is almost identical with that left after fracture of the neck. This is known as *interstitial absorption of the neck of the femur.* In many of its features it closely resembles rheumatoid arthritis, and it is well known that this sometimes attacks a single joint, almost to the exclusion of the rest, especially after injury; but these changes are not unfrequently met with in young adults, who, at the time at least, show no other sign of this disease; and an alteration of a somewhat similar character is found occasionally in connection with other bones, the humerus, for example, after fracture. All that can be said is that injuries of this description are sometimes followed by profound alterations in the nutrition of the part.

FRACTURES OF THE SHAFT OF THE FEMUR

These may be caused by direct or indirect violence, or by muscular action, and may affect any part of the bone from the lesser trochanter to the base of the condyles. In infants and children they are transverse and usually subperiosteal; in adults they are more frequently oblique, sometimes even spiral.

Compound and comminuted fractures are not uncommon, but impaction is rare, except at the lower extremity.

Displacement.—The relative position of the two fragments is dependent mainly upon the direction of the fracture. When it is transverse and the periosteum is not torn, there is merely a certain amount of angular bending; in all other cases the lower part of the limb rolls outwards, from its weight, until it lies completely upon its outer side, and is pulled upwards towards the trunk by the contraction of the muscles. There may be as much as three or even four inches' shortening in a muscular adult. The position of the upper fragment is not constant; it is generally rotated outwards to a certain extent, especially if the fracture is high up, by the muscles attached to the great trochanter, but never so far as the lower one, and it is usually flexed and tilted upwards, partly by the action of the iliopsoas, partly by the pressure of the lower fragment against its under surface. When the fracture is immediately below the lesser trochanter I have known it tilted to such an extent that the broken surface projected underneath the skin upon the front of the thigh.

Symptoms.—The ordinary signs of fracture are well marked; the limb is shortened, everted, and absolutely helpless; undue mobility and crepitus are always present, and there is always extreme pain about the seat of injury. Ecchymosis, however, owing to the deep situation of the bone, often does not show itself for some considerable time, in many cases not at all. Sometimes it is difficult to make certain of the exact position and direction of the broken ends, especially if they are very oblique, or driven deeply into the substance of the surrounding muscles, and it is never easy to appreciate the amount of comminution. The soft tissues rarely suffer to any serious extent in simple fractures, except when the injury is low down in the thigh; in those that are compound by direct violence, on the other hand, they are often hopelessly disorganised.

Union is generally sufficiently firm at the end of three weeks to allow the patient to get about on crutches with some fixed apparatus, but no weight must be placed upon the foot for at least ten weeks from the date of the accident, and in many instances, when the patient is corpulent or the fracture oblique, this time may be extended with advantage. Except in transverse fractures, shortening to the extent of half an inch is so common, in spite of every precaution, that it must be regarded as the rule; sometimes it is even worse than this, without its being possible to say that the case has been treated badly. Delayed union is not uncommon, and false joint may occur, especially when the fragments are oblique or are driven into the muscles around.

Treatment.—The simplest and most useful method for all ordinary cases is a combination of Liston's (fig. 133) or Desault's (fig. 134) long splint, with extension by means of a weight attached to the limb. Counter-extension is made, not with a perineal band, which is very apt to gall the patient, and in women is peculiarly objectionable, but by raising the foot of the bed, so that the body lies on an inclined plane. The splint must be sufficiently long to reach from the axilla to below the foot, the outer malleolus fitting into the hollow made to receive it, and sufficiently broad to be really on a level with the thigh; in cases in which the hips are prominent, the padding must be especially thick or the patient cannot lie straight, and there should always be a cross-bar screwed to the under surface at the lower end, to serve the double purpose of raising the heel well off the bed, and of preventing any rotation of the limb. A flannel bandage is first placed round the foot and the lower part of the calf; and then a piece of strapping two inches and a half wide, and twice the length of the distance from just above the patient's knee to six inches below the sole, is fastened to the limb, so that the two ends lie one on each side, and the loop projects below the foot. If the strips are arranged obliquely, the outer end winding round the limb towards the posterior surface, and the inner to the anterior, the extension helps, as soon as the weight is on, to correct the eversion of the limb. Transverse strips are then placed round the limb to hold this in position, the centre of each corresponding to the posterior surface of the leg and the ends crossing obliquely in front, until the whole is covered in from the middle of the calf to the condyles of the femur. The loop is held open with a wooden stirrup, which is perforated in the centre to allow of a cord being passed through, and is wide enough to prevent any pressure upon the malleoli; and the weight suspended from the other end of the cord by means of a pulley at the foot of the bed. The amount depends upon the degree of shortening and the strength of the muscles, but eight or ten pounds are usually sufficient (fig. 135).

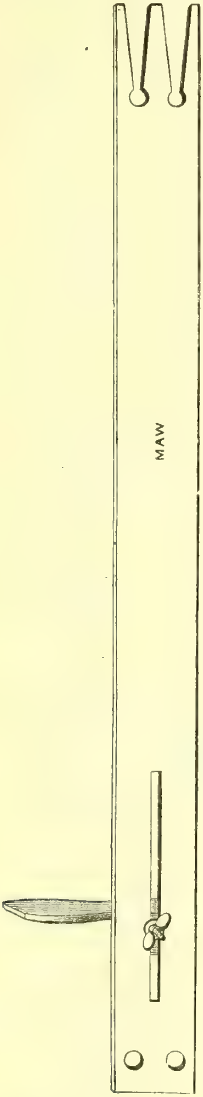

Fig. 133.—Liston's splint with sliding foot-piece.

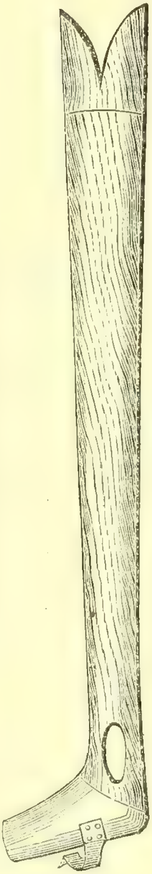

Fig. 134.—Desault's splint.

If the patient is under an anæsthetic the splint may be bandaged on at once; in other cases it is sometimes advantageous to wait until the next day, when the fragments have resumed their normal situation; the part in the meantime is kept steady by means of sandbags. The long splint is fastened to the outer side of the limb, from the foot to above the knee, beginning with figure-of-eight turns, wide enough to pass through the notches at the lower end of the splint, and to come well above the ankle; if any pressure falls upon the back of the heel, a sore is sure to form. In fractures near the middle of the shaft it is advisable to place a splint behind the limb to maintain the natural arch of the bone; the inner and anterior surfaces may be covered with felt or with Gooch's splint, cut to fit the part, and fastened on with straps and buckles (fig. 136). In other cases it is sufficient to carry the andage up from the knee over the seat of fracture. In bandaging a fractured femur the turns should be carried from the outer side over the front f the limb down the inner one, as this is of considerable help in correcting he eversion. Finally the splint must be secured round the waist, either by eans of a broad bandage, or a belt provided with straps and buckles, and the andages starched.

Liston's splint is made of wood four inches wide, and half an inch thick, long enough to reach from the axilla to six inches below the foot. The upper end is perforated for the attachment of a perinæal band; the lower notched, so as to afford a better grip for the bandage. Desault's differs in having a foot-piece to fit on the outer side, in being hollowed out, and in being much wider at the upper end than at the lower.

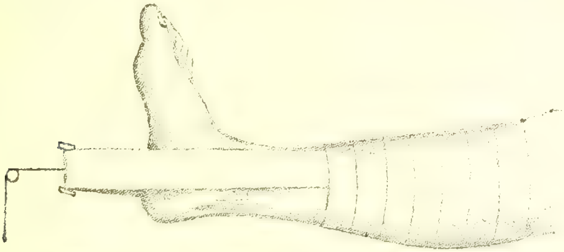

Fig. 135.—Mode of applying stirrup for weight-extension.

At the end of a fortnight or three weeks, according to the age of the patient and the direction of the fracture, this may be replaced, either by a fixed apparatus of gum and chalk, a starched bandage with longitudinal strips of torn pasteboard, or, better still, by a Thomas' knee-splint. This consists of a well-padded circle, fitted obliquely round the thigh as high up as it will go, two straight rods coming down from this, one on each side of the limb, and a small patten at the bottom, below the foot, to connect them together. If the stirrup has been well applied the long splint can be removed, a Thomas' splint fitted on, the weight cut off, and the cord fastened to the patten at the bottom without disturbing the limb in the least (fig. 137). In most instances it is advantageous to replace the cord by an elastic band, so as still to keep up a certain degree of extension, or the sides of the splint may e made so that the length can be altered at will. Anterior and posterior ooden or felt splints are necessary to protect the seat of injury, and the leg nd thigh must be firmly bandaged to the side rods. As soon as this is

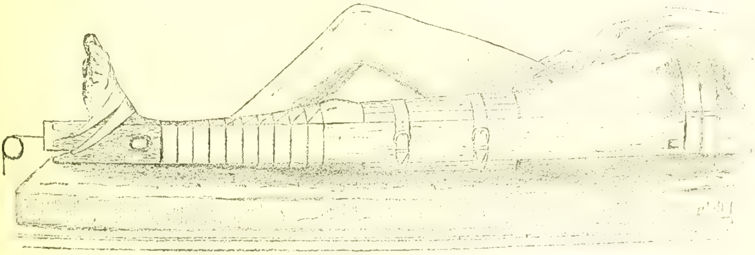

Fig. 136.—Liston's splint applied with Gooch's round seat of fracture.

secure the patient may be allowed to get about upon crutches, with a patten under the opposite foot; but, though the whole of the weight would be transmitted directly from the pelvis to the ground, it is not advisable to let him rest upon the splint patten for some weeks longer; the leg should hang from the hip-joint as a mere appendage. In some cases Thomas' splint is used from the first, but it is difficult to obtain the requisite amount of extension without galling the patient; after being kept steadily on the stretch for two or three weeks, the tendency to contract on the part of the muscles is very much diminished.

In fractures below the trochanters another plan must be adopted. Extension in a straight line does not in any way correct the deformity, and as it is impossible to influence the upper fragment materially, the lower must be adjusted to it. This is accomplished, either by laying the patient upon the injured side, and flexing the thigh upon the abdomen as recommended by Pott, or by making use of a double-inclined plane. The latter is the more comfortable: the patient can be propped up in bed so as to relax the iliopsoas still more, and there is less risk of bed-sores. A MacIntyre splint answers better still, and is less cumbersome. Whichever plan is adopted, extension is made from the lower half of the thigh by means of a stirrup and a weight suspended over a pulley at a convenient angle (fig. 139).

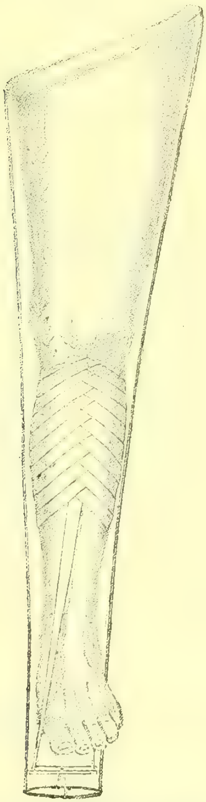

Fig. 137.—Thomas' brace splint with stirrup-extension. The anterior and posterior splints on the thigh and the bandaging are not represented.

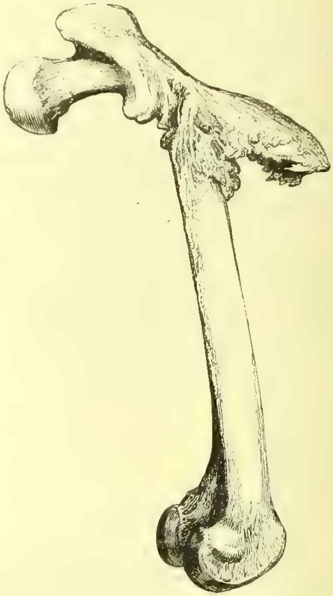

Fig. 138.—Badly united fracture of femur.

In cases in which there is a wound on the posterior surface, or the hip or knee is ankylosed in an awkward position, an anterior splint, either Hodgen's or Nathan Smith's, may be used. The former of these consists of two parallel metal rods, long enough to reach from the groin to below the foot, held apart from each other by cross-bars. The limb is suspended from between these by cotton sacking, or broad strips of flannel, so that it rests and makes a bed for itself in a kind of trough (fig. 140). The foot is fixed by a stirrup to the cross-bar at the end, and the whole is slung from a pole over the bed at such an angle that a certain amount of extension is kept up, the weight of the body acting as a counter-extending force. The knee-joint must be kept nearly straight. Nathan Smith's is either formed of a similar framework with the rods closer together, or of a single flat median bar. The limb is bandaged directly to its under surface, so that it must be bent to fit accurately, and then it is suspended in the same way. When properly adjusted these splints are exceedingly comfortable, but they are very difficult to arrange (suspending hooks should be made so that they can be fixed at any point); they do not secure the same degree of immobility, or maintain extension so well, and it is very difficult to prevent eversion with them.

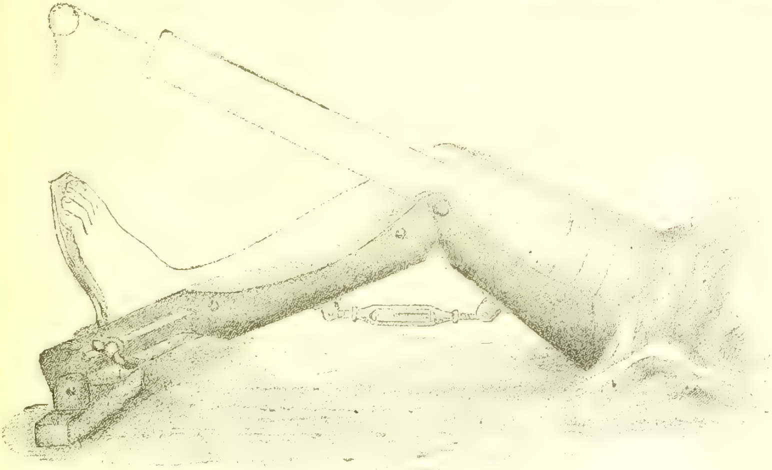

Fig. 139.—McIntyre splint with weight-extension from the knee in fracture of the femur below the trochanter.

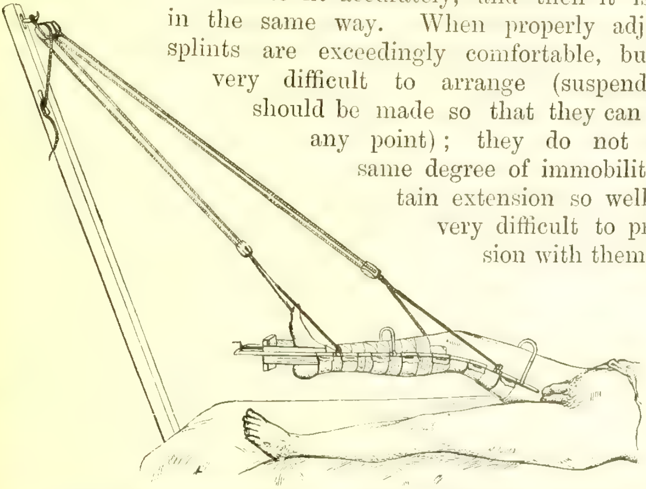

Fig. 140.—Dr. J. Hodgen's suspension splint, as used at Guy's.

Transverse fractures of the shaft in children may be treated in various ways. In very young infants, where the thick periosteum is probably intact all round, it is sufficient in many cases merely to lay the child upon a pillow on its injured side, with the hip and knee flexed. As a rule they lie remarkably quiet, and though the bone may not be perfectly straight, the angle is so slight, and the subsequent changes so rapid and extensive, that in a year or two it is scarcely perceptible. Union is fairly firm in ten days or a fortnight. In those a little older, vertical suspension of both legs is more satisfactory: a miniature stirrup is fastened on to each in the ordinary way; the cords are passed over two pulleys attached to a cradle or a horizontal bar over the child's body, and a weight is suspended from each just sufficient to keep the leg straight in a vertical position. A starched bandage is then placed round the thigh. The child soon becomes accustomed to the constraint, and the bandages remain dry and clean to the last. Bryant's splint, which is made of two long ones, one on either side of the body, connected together by an arch over the trunk, and a bar below the feet, is especially useful in the case of older children. Extension can be applied by a weight to the injured leg; it is impossible for the child to twist its body round, and the limbs are kept exactly parallel.

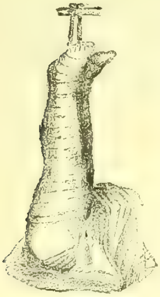

FIG. 141.—Plaster bandages and vertical extension for fracture of femur in an infant.

FRACTURES OF THE LOWER EXTREMITY OF THE FEMUR

These may be classified in the same way as fractures of the lower extremity of the humerus. The bone may be broken across altogether above the knee-joint, supra-condyloid; in addition to this the lower extremity may be split vertically in two, by the wedge-like action of the patella, T-shaped; one or other condyle may be detached; or the epiphysis may be separated. Impacted fractures are not uncommon, the lower end of the upper fragment being driven into the cancellous tissue of the other with sufficient force to become fixed in it, but not sufficient to break it into pieces. The lower end of the femur may be split vertically by the impact of the patella, without any transverse separation (fig. 142).

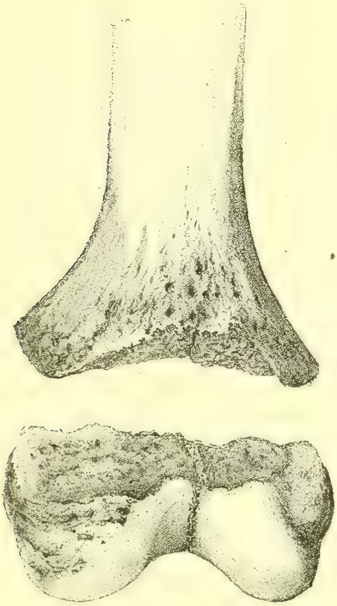

FIG. 142.—Shaft and epiphysis of femur separated by maceration. The epiphysis had been split in two about a year before the limb was removed, and union across the epiphysial line was osseous.

Supra-condyloid and T-*shaped*

These may be produced by direct or indirect violence; in the latter case the bone gives way at the junction of the compact tissue of the shaft with the expanded lower extremity; impaction is not unusual; and, if the force is very severe, the lower fragment is split into two (or even more pieces), the fracture assumes a T-shape, and the knee-joint is opened up. In the supra-condyloid form there is peculiar danger from the position of the popliteal vessels. The fracture is generally oblique from above downwards and forwards; the gastrocnemius, pulling on the lower fragment, causes it to rotate; the fractured surface is directed backwards, the normal anterior one upwards; and if any extension is made upon the leg the vessels are almost certain to be compressed, perhaps even torn.

The same thing occurs when the displacement is in the opposite direction, if the lower end of the upper fragment comes in contact with the artery (fig. 143). The synovial membrane of the knee-joint may be torn under the quadriceps tendon so as to communicate with the fracture, even when there is no vertical fissure running down.

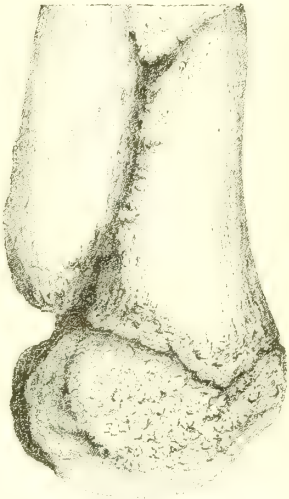

Fig. 143.—Fracture of lower end of femur with displacement of upper fragment backwards. About a year after the accident the projecting end wore a hole in the popliteal artery, and gave rise to an arterial hæmatoma.

Signs.—Shortening, deformity, pain, and swelling are so conspicuous that, even if the fragments are impacted, there is little difficulty in the diagnosis. If they remain loose, crepitus and undue mobility are present as well. When the knee-joint is involved the synovial cavity becomes distended with blood; if the condyles are separated, they can be made to work backwards and forwards upon each other, by pressing on them alternately; and there is an increase in the transverse measurement of the part. When the popliteal artery is torn, or wounded, an immense swelling forms with great rapidity in the popliteal space, filling it up completely, and the limb becomes cold and pulseless; if it is merely pressed upon, the temperature of the limb falls more gradually, but in spite of the collateral circulation, the same result generally ensues.

Treatment.—This depends to a great extent upon the direction of the fracture and the amount of injury done to the knee-joint. Shortening is very common, unless the fracture is transverse, and nearly always there is some impairment of movement, partly owing to the difficulty of restoring exactly the outline of the articular surfaces, partly from the formation of adhesions. The condition of the posterior tibial artery requires even more than ordinary attention. Liston's long splint and weight extension from the leg may be used, if the upper fragment has a tendency to backward displacement: in all other cases either the limb must be placed on a double inclined plane (or a McIntyre splint) or the tendo Achillis must be divided. The latter is preferable, as, owing to the small size of the lower fragment of bone, it is almost impossible to make satisfactory extension from it with the knee flexed. If the knee-joint is involved, the distension of the synovial sac must be reduced as soon as possible by cold, pressure, and even aspiration, though this should only be resorted to when the case is really urgent. Then the fragments must be replaced by manipulation, and fixed by pressure, taking care to cover them with a thick even layer of cotton-wool. Passive motion of the joint should be commenced not later than the end of the fourth week. If the popliteal artery is wounded, an attempt may be made to secure the two ends by ligature; but very often the vein is injured as well, or the fracture communicates with the joint, and either gangrene sets in or the knee is disorganised to such an extent that the limb has to be amputated.

Separation of a Condyle

It occasionally happens as a result of direct violence, or even it is said from forcible rotation, that one of the condyles is detached from the rest of the bone without the shaft being broken across. The symptoms depend upon the amount of comminution; the joint becomes distended with blood, generally at once, but in one case under my care this was not marked in degree for several hours; the length of the limb is not altered; pain on pressure is very great; and crepitus and undue mobility are usually distinct. A fixed bandage, with a thick layer of cotton-wool over the joint, should be applied as soon as the fragments can be manipulated into position; but as absorption proceeds it will probably require to be replaced in the course of a few days. Passive motion should be commenced not later than the third week.

Separation of the lower epiphysis is not an uncommon form of accident; it can only occur under twenty years of age, and is rarely met with over sixteen. Generally speaking it is produced by indirect violence, forcible wrenching or twisting, but it may be caused by direct. The knee-joint is almost certain to be involved, though it is anatomically possible to separate the epiphysis without opening the synovial membrane. The symptoms are almost the same as those of the supra-condyloid variety, from which it can only be distinguished by the age of the patient, the absence of true crepitus, and the position of the adductor tubercle. The displacement and the treatment are the same, though owing to the concave shape of the upper surface of the epiphysis there is not the same tendency to backward rotation of the lower fragment.

Compound Fractures of the Femur

These may occur either from direct or indirect violence. The latter are not common, partly because the bone is situated at such a depth, partly because it is so impossible for a patient with a broken thigh to try to stand: most of them occur at or near the lower third, and frequently they involve the knee-joint.

When they are due to direct violence, the injury to the soft parts is generally so extreme that there can be but little hope of saving the limb, especially as the skin is not unfrequently destroyed far above the point at which the bone is crushed. The only question is when amputation should be performed. In the case of the upper part of the femur, this operation, when primary, affords so little hope, that, unless in exceptional instances, it is practically abandoned: hæmorrhage must be checked, not merely that from the main artery, which seldom bleeds, but the capillary oozing, for this, though almost imperceptible at any given moment, is very serious from its persistence; putrefaction must be prevented, especially in the region of the bone, where it is exceedingly prone to occur; and every effort must be made to restore the patient's temperature and tide him over the shock. When reaction has fully set in the mangled part may be removed and the stump trimmed without so much risk. If the injury involves the lower half, amputation may be performed as soon as the patient is in a fit state to bear it; but, unless it is done immediately after the accident, so that the operation is really primary, it is better to treat the case in the same way as a fracture of the upper half, and wait till the second or even the third day.

In fractures that are compound by indirect violence the prospect is much better, and even when the knee-joint is involved the limb can usually be saved. The treatment must be guided by the age and constitution of the patient and by the nature of the injury. A mere puncture may be dusted over with iodoform and sealed beneath an absorbent dressing, the wound and the bone, if it protruded, having first been thoroughly cleansed with corrosive sublimate or some other antiseptic. A larger opening should be carefully explored with the finger, washed out to its utmost recesses, and either drained with counter-openings or left gaping to a certain extent. If the bone is comminuted, any loose splinters may be removed; and if the fragments are much displaced they may be sutured together, but this is rarely possible in the case of the femur without enlarging the opening very considerably. Wound of the femoral artery does not of itself require amputation in a case of compound fracture; injury to the vein appears to be more serious.

The same line of treatment must be pursued when the fracture extends into the knee-joint; but it must not be forgotten that, though the opening on the surface may be small, the real size of the wound is equal to that of the synovial membrane. Every effort must be made to prevent inflammation: the part itself must be thoroughly cleansed; the wound, if more than a puncture, washed out from the bottom with an antiseptic and drained; the limb placed upon a MacIntyre splint; cold and gentle pressure applied to the joint; and an ice-bag laid upon the femoral artery if there is the least sign of heat in the limb. If, in spite of these precautions, the joint swells up and becomes tense, and if the skin over it becomes red and œdematous, and the patient's temperature begins to rise, free incision should be made on each side into the joint, and thorough drainage carried out. Even then the articulation may recover, though suppuration, with destruction of the cartilages and ankylosis, is a more probable result; and secondary amputation may be required to prevent the patient sinking from exhaustion.

FRACTURES OF THE PATELLA

These are nearly always the result of muscular action; occasionally they are produced by direct violence. In the former case the line of separation is always transverse, though it may run across any part of the bone; the fascia is torn to a greater or less extent; the amount of separation is generally considerable; and union by bone is the exception, not the rule. In the latter the fracture may be stellate, vertical, transverse, or comminuted; the fascia covering it and attached to the sides is not torn; the amount of separation between the fragments is not exceptional, and union nearly always takes place by bone (figs. 144 and 145).

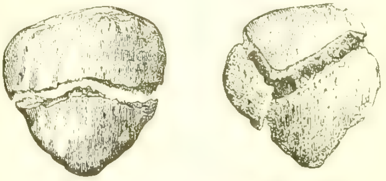

Fig. 144. Fig. 145.
Transverse and stellate fractures of patella.

Fracture by Muscular Action

The frequency with which this takes place is accounted for by the anatomical relation of the part. When the knee is flexed, the lower half of the patella rests upon the prominent portion of the condyles of the femur, the upper is entirely unsupported, and the plane of the bone is almost at right angles to the direction of the quadriceps. If this muscle suddenly contracts the whole of the strain falls upon one spot, and the bone gives way just as when a stick is snapped across the knee. The patient is conscious of something breaking before he falls, and it sometimes happens that, in the desperate effort to save himself, the other patella snaps across as well. I have known this occur to a man in the first stride of a race.

Displacement.—The amount is very variable, and depends upon the laceration of the fascia ; if this does not give way there is no separation. At the first instant it is caused by muscular contraction, and it is often made worse by attempts to stand or walk. Afterwards the broken surfaces are forced asunder by the effusion into the joint, and the separation is kept up by clotting of the blood in between, or by tilting of the fragments owing to the insertion of the tendon into the edge of the anterior surface of the bone ; or by shreds of fascia and sometimes even the skin being driven down into the gap. In old cases the upper fragment is often practically immovable, either because it is fixed to the femur or because the muscular substance of the quadriceps has undergone degeneration. The outer edge of the patella is longer than the inner, so that when the two fragments are brought together they do not meet on the inner side, and in cases of fibrous union the inner part is usually longer than the outer (fig. 147).

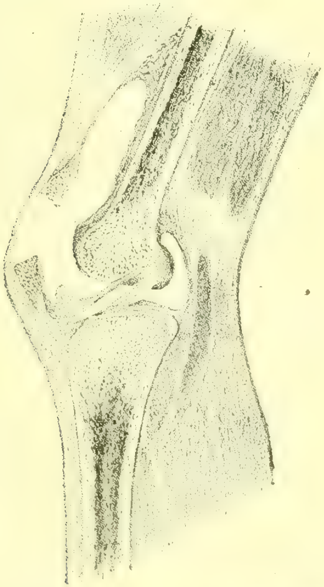

Fig. 146.—Section through knee after fracture of patella, showing displacement.

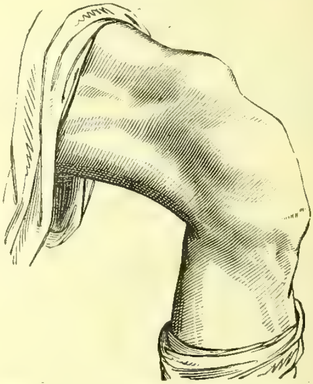

Fig. 147.—Knee in a case of fractured patella.

Symptoms.—There is rarely any difficulty in the diagnosis, though occasionally when there is a thickening in the bursa over the bone, or extravasation of blood into the periosteum, a deceptive transverse depression may be felt. As a rule there is wide separation, the fragments are distinct and can be moved from side to side, or one can be tilted by direct pressure without the other; swelling sets in at once and assumes the shape of the synovial membrane of the joint; crepitus, of course, is not present unless the upper fragment can be pressed down and brought into contact with the lower; the loss of power over the quadriceps is complete in proportion to the separation of the fragments and the tearing of the fascia; in a very few instances the patient has been able to raise and extend the limb.

Prognosis.—Union may take place by bone, though this is rare, or by fibrous tissue, the broken surfaces being united directly to each other face to face; or there is no true union at all, but merely a thickened layer of fascia passing over the anterior surface of the fragments from one to the other. In no case does the quadriceps, especially that part of the vastus internus just above the knee-joint, completely recover. If there is good fibrous union, with not more than half an inch interval, the use and the strength of the limb are scarcely impaired; when the fascia is the only uniting medium, though the interval may be small at first, it is sure to elongate, until it may be as much as five and even six inches (figs. 148 and 149).

Flexion is permanently impaired in many cases; in a few the knee remains quite stiff, and occasionally the upper fragment becomes attached to the femur.

As vertical fractures almost invariably unite by bone, and as in some few cases the amount of callus thrown out is so great as to interfere with the gliding of the patella on the femur, it is clear that the failure of union is due mainly to the fragments not being in contact—they are kept apart either by the effusion, or by being tilted, or by the fascia being pressed down between them and entangled by the broken surfaces; and the amount of callus formed is not sufficient to bridge the interval; none is thrown out by the articular surface, and very little by the cutaneous.

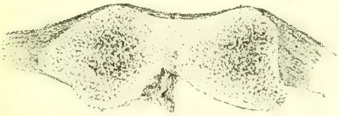

FIG. 148.—Osseous union of transverse fracture of patella. From a subject in the dissecting room. There was no scar visible on the skin.

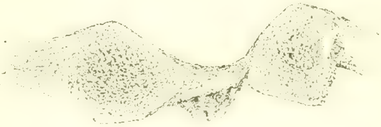

FIG. 149.—Fibrous union of the corresponding bone on the opposite side.

Treatment.—Where the effusion is only slight, and the fascia at the sides of the patella is not torn, there is little difficulty in maintaining the fragments in contact, especially if they are of equal size. The knee must be kept straight on an inclined plane, the hip slightly bent, and the whole limb encased in a starch bandage, carried in figure-of-eight turns over the knee right up to the groin. A short back splint or a firm pad in the popliteal space is advisable to make it more secure. The effusion rapidly becomes absorbed, the fragments are drawn together by the bandage, the amount of tilting is very slight, and the even pressure round the quadriceps checks any tendency to spasmodic contraction. No lateral movement of any kind should be allowed for at least six weeks, even to test the degree of union; little bony spicules are occasionally found shooting through the lymph from one fractured surface to the other, and all of these would be broken off at once.

In the majority of instances, however, something more than this is required. Every effort must be made to get rid of the effusion as soon as possible; not only does it force the two fragments apart, but it stretches the membrane, and makes it thick and stiff, so that it interferes with the freedom of movement afterwards. Cold is of great service at first, but it can only check exudation, not assist absorption; pressure properly applied over a thick layer of cotton-wool is much more effectual; but if at the end of three days there is much left, the joint should be aspirated. It is true that, unless proper precautions are taken, this proceeding is attended with a certain amount of risk; and that sometimes it is impossible, owing to the density of the coagula, to empty the articulation completely; but many of the cases obstinately resist for such a length of time that nothing else is of any avail. The opening, which is best made above and to the inner side of the patella, should be valvular, and if a cannula is used it should be cleaned well first by boiling it in a solution of caustic potash.

Sometimes after this is done the fragments come into apposition almost of themselves; more often something further is required to bring them together. The simplest apparatus is a back splint, rather wider than the limb, and hollowed out to fit the knee. Two hooks are screwed into each side about eight inches apart, one above the joint, the other below; and two elastic bands are fastened to these, so as to loop over the limb in a figure-of-eight. The lower one passes above the patella, and tends to draw the upper fragment down; the upper one, crossing this, catches the ligamentum patellæ and forms a fixed point. The skin, which is very freely movable over the knee, should be stretched away from the seat of fracture as far as possible before this is applied, or it may be forced down between the broken surfaces. The chief disadvantage is the liability to tilting of the fragments.

A better plan is to mould a piece of thin poroplastic felt or thick moleskin over the front of the thigh, cutting it out so as to fit round the upper margin of the patella, and leaving on either side a loop or a projection to which an elastic band can be attached. The limb should be fixed in a MacIntyre or a Thomas' knee splint, and the elastic bands drawn down, one on each side, and secured to the foot-piece. At the same time a strip of bandage or plaster must be carried over the upper fragment to prevent it rising. At the end of a fortnight or three weeks the whole limb may be encased in a fixed apparatus and the patient allowed to get about on crutches (fig. 150).

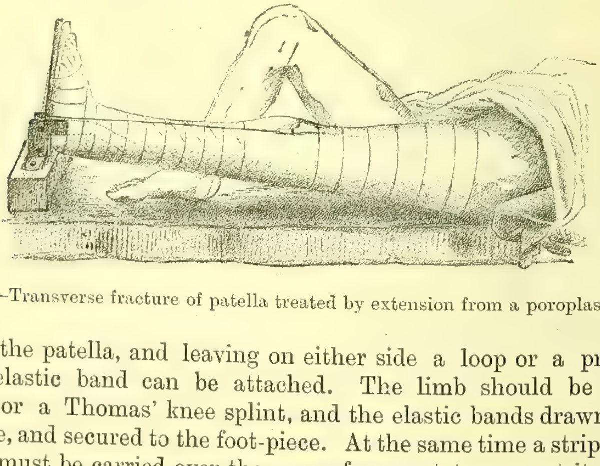

FIG. 150.—Transverse fracture of patella treated by extension from a poroplastic shield.

If due precautions are taken, Malgaigne's hooks may be used with a fair degree of safety (fig. 151); and, so far as mechanical reasons are concerned, nothing can answer better, especially if the instrument is divided longitudinally, so that there are two halves, right and left, which can be screwed up separately. The limb must be secured to a back splint, so as to keep it at perfect rest in complete extension; the fragments must be brought down to their definite position; and a minute puncture made with a sharp-pointed scalpel at the spot the hooks are intended to penetrate. The two upper should be carried right down to the bone, and, as suggested by Treves, may be made use of to evacuate the fluid from the joint; the lower do not involve the synovial membrane. Then the hooks are inserted, the lower ones being fixed first, and screwed up until everything is in position. If there is any tendency on the part of the upper fragment to ride forward, it may be checked by carrying a tape round the limb and the splint, and tightening it up as required. The pain is very slight, not sufficient to require an anæsthetic; the fragments can be adjusted perfectly; and if the little wounds are dusted over with iodoform and kept dry and quiet, there is little risk of inflammation.[1] In former days there is no doubt this was not an unfrequent consequence. The hooks may be kept in for six or eight weeks without any ill consequence; but there is no advantage in retaining them for more than three; at the end of that time the limb is generally sufficiently secure to be enclosed in a fixed apparatus. The plan of fixing the hooks into crescents of felt or moleskin strapping, fastened to the skin above and below, does not present any advantage over other methods.

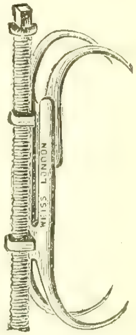

FIG. 151.
Malgaigne's hooks.

Many other plans have been devised for bringing the fragments together by means of pins or hooks fixed in the bones. Transverse channels have been drilled through the two fragments from side to side, and wires or pins passed through. Longitudinal ones have been tried, without any incision other than that required to admit the point of the drill. Pins have been driven into the ligamentum patellæ and the tendon of the quadriceps, so as to obtain some fixed point. They have all succeeded, but they are none of them devoid of risk.

Laying open the knee-joint, and converting a simple fracture into a compound one, has been strongly recommended, even in recent cases: and it is worthy of consideration in exceptional instances in which it is impossible, in spite of every endeavour, to bring the two fragments face to face. The risk, however, even with the strictest antiseptic precautions, is much too great; especially as in young and healthy subjects, firm fibrous union, leaving a strong and useful limb, may be reasonably counted upon without. A vertical incision, two inches in length, is made over the anterior surface of the bone with its centre opposite the line of fracture. The joint is opened freely; all blood-clots turned out; and then two holes are drilled obliquely, from the cutaneous to the fractured surface, so as not to involve the cartilage. A stout silver wire is inserted through these; a drainage-tube passed through the deepest part of the joint upon the outer side; the fragments brought together; the wire twisted up and the ends cut off and hammered down. Others recommend a transverse incision above or below the line of fracture, on the ground that if suppuration occurs in the skin wound the deep one is less liable to be infected. It is true that bony union has taken place in the majority of cases operated on; but suppuration has occurred in several, in spite of antiseptic precautions; ankylosis of a greater or less degree has followed in many; and in one or two the bond of union has broken down again and further operation has been required.

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[1] The hooks as originally devised by Malgaigne were very sharply curved so that the points should not penetrate the joint.

The only other plan that requires special mention is that first devised by Kocher. It consists in passing a stout silver wire completely round the patella. A needle in a handle (such as is used for sewing up a lacerated perinæum, only longer, stouter, and with a wider curve) is passed through the ligamentum patellæ, through the tendon of the quadriceps and out through the skin. It is then threaded and drawn back again; the broken fragments are brought together; the wire twisted up, over something to protect the skin; and the openings dusted over with iodoform. The limb is then placed upon a back splint, and carefully bandaged, for three weeks. At the end of that time the wire is cut, drawn out of the wound, and the little ulcers that are left dusted over again with iodoform until they are healed. I have known this employed in a large number of cases without untoward result of any kind; and the union was always exceedingly close, though I am bound to confess it was not possible to prove in the majority that it was osseous.

The after-treatment of a case of fractured patella requires just as much care. It is not uncommon to find that the distance between the fragments, even though it is scarcely half-an-inch at the first, in a few months grows larger and larger, until it may be as much as five or even six inches. In the majority no doubt this is due to the fact that there is no true union at all; but in very many it is the result of allowing the joint to bend too soon and throwing an undue strain upon newly-formed fibrous tissue. In all cases of transverse fracture the limb should be thoroughly encased, without being touched, for at least six, or preferably eight weeks: and then an apparatus must be worn, so that there can be no attempt at flexion for at least as many months. The best are made of leather, laced up at the sides, with an opening in front for the patella, and a steel rod behind, so that bending is impossible; but a very serviceable splint may be made from poroplastic felt, or even from gum and chalk. At first it should be left off at night only, and then by degrees more and more, until at the end of a twelvemonth it may be dispensed with altogether. For a time, of course, the joint is stiff, and the quadriceps wasted, but (with the exception, as already mentioned, of a portion of the vastus internus) this soon passes off; and if there is good fibrous union it does not stretch, no matter what strain falls upon it. Massage, hot douching, galvanism, and gentle passive motion may be used to expedite matters, but, as a rule (unless the patient is gouty or rheumatic), the stiffness disappears at length of its own accord (fig. 152).

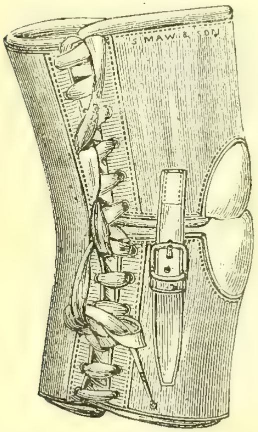


Fig. 152.—Apparatus for fibrous union of patella.

Imperfect repair.—The question of operation in these cases rests upon entirely different grounds; union by ordinary methods has been tried, and failed; and it depends upon the degree of utility the limb possesses, upon the strength and occupation of the patient, whether he should be recommended to get about with the support afforded by a knee-cap, or whether an attempt should be made to obtain firmer union. The operation itself is carried out in exactly the same way: the tissue between the broken surface must be removed thoroughly, and either the fragments drilled together or a wire passed round them after Kocher's plan: whichever is adopted it is essential that the apposition should be accurate. If an operation of this kind is attempted, it is advisable not to wait too long: when the quadriceps has once undergone degeneration, it is almost impossible to bring the upper fragment down sufficiently: the adhesions between it and the femur may be torn, the tendon divided, and even V-shaped incisions made in the muscular substance above it, without its being possible to bring it close enough to ensure good union.

Refracture occasionally takes place, the fibrous band tearing across, or the bone giving way at a fresh place. If it is simple, it may be treated in the ordinary manner, and it is surprising how far recovery can take place, and how useful the limb can prove; if compound, the fragments had better be wired together at once. In one or two instances, in which the interval was too great, resection of the knee-joint was performed in the hope of giving firmer support.

Fractures by Direct Violence

In these the fascia attached to the bone is seldom torn, and the degree of separation is slight, even when the joint is filled with blood. The treatment is the same as for transverse fracture without displacement; but, as union is nearly always osseous, passive flexion of the limb may be commenced much sooner.

Compound Fractures

When the accident is the result of direct violence the injury is rarely confined to the patella: generally the other bones are involved as well, and often the soft parts are extensively destroyed. In former days, amputation was regarded as inevitable for such injury as this: at present, if the part can be thoroughly cleansed and thoroughly drained, a successful result may be hoped for, even when such an amount of bone is removed that practically it becomes a primary resection. If, however, the skin is extensively damaged, or if the popliteal artery or vein has been torn or punctured, there is no alternative.

Fractures by muscular action are occasionally compound, especially when the bone gives way for the second time. In one case under my care the skin was torn across from one side of the joint to the other; but though the patient (who was a coalheaver) was not brought to the hospital for some hours after the accident, union took place by the first intention, without the least fever. If it is feasible the fragments should be wired together at once; if it cannot be done the joint may be resected; but probably a better limb would be left by drawing the fragments as close together as possible and making the patient wear a support for the rest of his life.

FRACTURES OF THE LEG

Both bones may be broken; or the tibia or the fibula may give way by itself. If the violence is indirect, the tibia generally breaks across at the junction of the lower with the middle third (the weakest part), and the line of separation runs from above downwards and forwards; the fibula usually gives way higher up. If direct it depends upon the nature and locality of the injury. In either case compound fracture is very common, owing to the thinness of the covering over a great portion of the tibia; and all kinds of complications are frequently present. The bone may be comminuted, even when the force is indirect; the neighbouring joints may be involved, though the seat of injury is a long way off, owing to the way in which fissures run obliquely, or even spirally, in the thickness of the bone; the veins and arteries may be compressed, punctured, or torn completely in two; the muscles extensively lacerated; the nerves stretched across sharp-edged fragments; and the skin, even when it does not give way, stripped up to such an extent from the deep fascia, that it seems to float upon a kind of water-bed, and is in imminent danger of gangrene.

Fractures of the Tibia and Fibula

This is the most common form, whether the accident is the result of direct or indirect violence. In the former case the fractures may be transverse and on the same level; or they may be comminuted to any degree: in the latter they are usually more or less oblique (especially if there is much twisting of the limb), and the broken ends are sharply pointed. In falls upon the feet, particularly when the force is very considerable, and combined with rotation, as in jumping from a carriage in motion, the bones are frequently broken in more places than one.

The displacement is usually distinct at the first glance, though, sometimes, when the fracture is exactly transverse, and through the upper part of the leg, or when the surfaces are much serrated, the broken ends retain their normal position. The causes of the deformity are the continuance of the force after the bones have given way, the weight of the part and the spasmodic contraction of the muscles; its persistence (unless there is impaction) is due entirely to the two last, and especially the muscles. The direction depends upon the obliquity. If it runs from above, downwards, and forwards, the lower end of the upper fragment projects beneath the skin, being driven to the front by the pressure of the other; if it has the opposite direction, the lower of the two is the more prominent. The fibula has very little influence.

Signs.—These are usually definite, though a few cases are on record in which a person with both bones broken has been able to stand, and even walk. Crepitus, undue mobility, and deformity are almost invariable; pain is intense, and increased by the lightest pressure; and loss of power is practically complete. The greatest care must be taken in manipulation to prevent the skin giving way; and, for the same reason, the limb must always be made secure at once. It should be a rule to examine the condition of the arteries, particularly the posterior tibial, in all fractures.

Treatment.—Fractures of both bones may be divided roughly into three classes.

(*a*) If the limb is so badly crushed that it is doubtful whether it can live, it is better to arrange it as comfortably as possible between sand-bags, or to tie it up in a pillow, so as to make it secure against any incautious movement, and raise it well, in the hope that the circulation may recover.

(*b*) If the fracture is transverse, or nearly so, and if, as usually happens in these cases, the surrounding structures have almost escaped, there is no reason why the limb should not be put up at once in some form of immovable apparatus. This holds good with even greater force when only one bone is broken and the other is left as a splint.

(*c*) If the fracture is very oblique, particularly if it is of that variety which is sometimes called pen-nib, from the way in which the point of one of the fragments projects beneath the skin, or if the bone is extensively comminuted, or the soft parts much injured, and the swelling already serious, it is safer to postpone this for ten days or a fortnight, and to make use of ordinary splints, until the tendency on the part of the muscles to cause displacement has in some measure disappeared, and the swelling and tension are beginning to subside; with such an injury there can be no object in getting the patient out of bed.

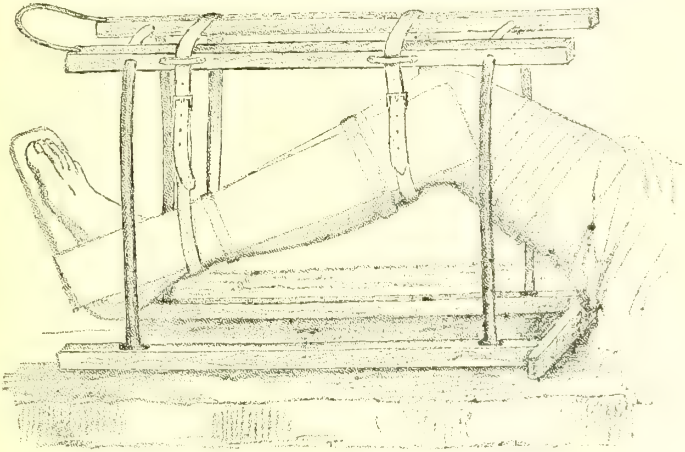


FIG. 153.—Back and side splints, slung from a cradle. The side splints are not quite deep enough at the upper end.

The variety of splints that have been devised for fractures of this kind is almost endless. The great object is to secure muscular relaxation; the fragments should fall of themselves into their natural position; force must be avoided as much as possible, though in a few cases continuous extension answers where nothing else will. One of the simplest and most efficient appliances consists of a back and two side splints swung from a cradle (fig. 153). The former is made of metal, sufficiently strong to retain its shape, but capable of being bent, and should reach from half-way up the thigh to form a sole-piece for the foot. At the heel there is a large perforation to avoid pressure, and two cross bars to sling it by are soldered to the under surface. It should be fitted accurately into all the curves of the opposite limb before being padded: and especial care must be taken to make the bend correspond with the position of the knee; extra pads to exert special pressure on certain points should be used as little as possible. If the sole-piece is at right angles to the leg (or with advantage a little less), and if the knee is sufficiently flexed (as much as 60° if necessary) the broken fragments fall into their natural position of themselves. Division of the tendo Achillis, though perfectly safe, is very rarely required, and continuous extension is seldom of service, except in those rare instances in which, owing to the direction of the fracture and spasmodic contraction of the quadriceps, the lower end of the upper fragment is tilted forwards. The secret is to keep the knee well bent, the foot at right angles, and the inner side of the great toe, the inner malleolus, and the inner border of the patella in the same line. Strapping may be used to secure the foot, but bandages only should be allowed above the seat of injury, and for the sake of neatness they are to be starched. The side splints are simply straight pieces of deal, well padded, sufficiently long to reach from the condyles of the femur to the foot and sufficiently broad to project well above the level of the limb. Webbing straps and buckles are used to hold them together, and the whole is suspended by leather bands from a cradle sufficiently large to allow it to swing freely. No movement of the patient in reason can have any influence upon the fragments; but he should not be allowed to lie upon the injured side, for fear of the upper part of the limb becoming rotated while the lower is held fixed.

Another plan is to lay the limb upon its outer side, on a well-padded wooden splint, with the hip and knee flexed, and the foot kept at a right angle by means of a sole piece. The splint should be hollowed to fit the limb, sufficiently long to reach up to the knee, with a prolongation along the side of the foot, and the sole-piece screwed to it at a right angle. Opposite the malleolus there should be a perforation to avoid pressure. The patient is placed upon the injured side; the fragments manipulated into position, and the limb secured by bandages. Care must be taken to keep the heel well down, and the foot at a right angle, for fear of the ankle becoming rigid. If there is any tendency to lateral projection, a short inside splint may be added with advantage.

In some instances the limb may be suspended from an anterior splint, either Hodgen's (fig. 140) or Nathan Smith's, as already described, the angle and the point of suspension being altered to fit the case; it is easy to make extension, and the limb, when it is once adjusted, is exceedingly comfortable, but it is very difficult to prevent the foot from pointing, and they certainly do not secure the same degree of immobility as the others. Probably the majority of the fractures that admit of being treated in this way might as well be put up at once in one of the many forms of immovable apparatus.

At the end of ten days or a fortnight, according to the condition of the fracture, the splints may be removed and some form of immovable appliance substituted, such as an ordinary plaster-of-Paris or gum and chalk bandage. Care must be taken first to get rid of all œdema by means of elevation and pressure. The following plan, for the details of which I am indebted to Mr. E. N. Nason, is in common use at the London Hospital. Equal parts (by weight) of finely powdered prepared chalk and common gum acacia are taken; the latter is made into mucilage, somewhat stronger than the B. P. strength, and is then thoroughly mixed with the chalk, until the whole is about the consistence of cream; this is strained through coarse muslin in order to get rid of the lumps. The leg is then thoroughly oiled, and a common cotton stocking, with the point of the toe cut off and large enough to fit easily, is put on outside inwards, a piece of stout tape being arranged along the front of the leg beneath it. A second stocking, slightly larger than the first, is put on over this, the leg is supported in position, taking care that the foot is at a right angle, and the mixture of gum and chalk is thoroughly rubbed in. A third stocking of the same size as the second one is now drawn over the other two, right side outwards, and more of the mixture rubbed in until no more can be absorbed, and the ribs of the stocking show up clearly. The whole is then suspended by the tape, which lies beneath all the stockings, slung from a cradle and left to dry. This takes eighteen hours, unless quickened by placing the patient near the fire, or putting hot-water bottles on either side; the limb, of course, being kept outside the bed-clothes. If silicate of potash is used instead of gum, a somewhat better splint results. The solution (which can be obtained in gallon jars) is mixed with the chalk in the same way, but not so much chalk is required, and it only takes six hours to dry. When the splint is firm, it is cut down the middle line in front, along the tape, trimmed up, and the edges bound with strapping to prevent fraying.

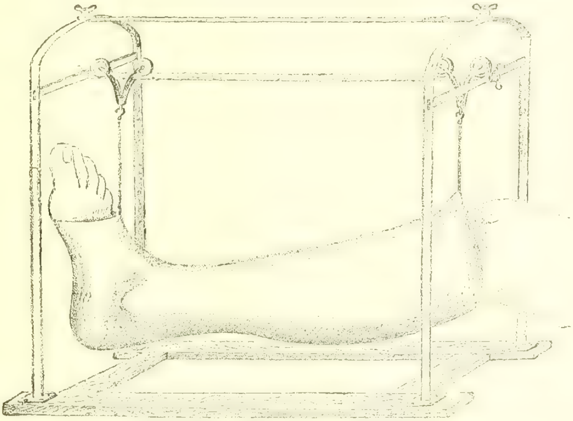


Fig. 154.—Stocking splint.

Eyelet holes are then punched on each side, and eyelets put in and clamped vith the instruments commonly used by shoemakers. The leg is enveloped n a Domette or soft flannel bandage, the splint put on and laced up the front s tightly as may be required. For lightness combined with strength these plints can hardly be surpassed; the fit is perfect, and at the same time they re sufficiently elastic to be taken on and off if required without injury. The lan of suspending the limb by the tape is not only of assistance in dividing he splint, but helps materially to keep the foot at a right angle; unless this osition is obtained the splint must be condemned at once.

Many cases of fracture, especially if only one bone is broken, as already nentioned, may be put up immediately; but either the splint must be made n two halves or it must be cut down the centre, and laced or fastened up gain in some other way, so that in case of swelling the seat of injury is ccessible at once. As a matter of precaution the limb should be raised or forty-eight hours after the splint is applied, and the circulation in the oes must be constantly examined. Absence of pain is not by any means ncompatible with gangrene.

Poroplastic felt splints (which may be obtained in sizes shaped already to some extent at most instrument-makers) answer admirably. They should be fitted roughly to the other leg so as to make sure that the length and breadth are correct, softened with heated air or water, and then moulded to the fractured limb while it is held in position. They become dry and firm in a few minutes, and then they can be removed, lined with wash-leather, and either fitted with eyelet-holes and laces, or fastened on directly with webbing straps and buckles.

Plaster-of-Paris is more extensively used for this purpose, especially since what is called the Bavarian splint became known: before this bandages of crinoline muslin, into which the dry plaster had been rubbed, were wound round and round the limb until the requisite degree of strength was obtained; and if it was desired to loosen or remove this, it had to be cut, and probably was spoilt. The plaster must be the finest, such as modellers use, and freshly prepared, or, if there is the least doubt, baked; the setting may be quickened by the addition of a small quantity of alum to the water. Two pieces of coarse house-flannel are taken, long enough to reach from the popliteal space to the balls of the toes and three inches wider than the circumference of the limb: these are sewn together down the middle line for the length of the leg; below this (for the length of the foot) they are cut in two. A very good idea of the shape and size required may be obtained by taking a stocking, cutting the toes off, slitting it down the middle line in front for the whole length, and down the middle line of the sole behind; but the flannel must be three inches wider. The leg is then placed upon the flannel so that the seam runs down the back and ends at the point of the heel; and the inner layers are folded over and fastened together down the front. The end portions are used to cover in the foot, which must be kept exactly at a right angle. The leg is then placed upon one side, and held accurately in position; a layer of plaster the consistence of cream is spread over the inner layer, from the fold in front to the seam behind, and the outer one pressed down upon this before it has set (fig. 155).

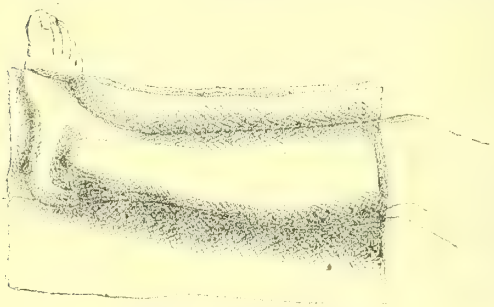


FIG. 155.—Bavarian splint.

As soon as it is firm the leg is turned over and the process repeated on the other side. Finally, the fastening down the front is undone, and two side splints, fitting accurately to the leg and foot, fall apart from the limb, bending at the hinge formed by the stitching behind. The edges are finished off afterwards, the inner layer being fastened down to the outer on the surface of the splint.

Modifications of this, introduced by Croft and Gamgee, are simpler of execution, as the side splints are separate throughout. For the former, four pieces of house-flannel are taken, the size and shape of the patient's stocking when flattened out; two of these (one for each side of the limb) are dipped in warm water, to go next the skin; the two others, the outer ones, are thoroughly soaked in plaster the consistence of cream. A bed is then prepared for the leg, consisting first of a layer of stout muslin cut so as to act after the fashion of a many-tailed bandage; then one of the pieces that have been dipped in plaster, and a second simply wetted. On this the leg is placed, the surgeon making extension and adjusting the fragments as far as possible; then the other pieces are laid upon the upper surface, and the muslin is brought up and fastened over the limb so as to press the layers of flannel against it. In this way two strong plaster moulds are made, one for each side, fitting the leg accurately; and as soon as the plaster sets they can be separated by simply cutting the muslin.

In Gamgee's method the principle is the same, but instead of house-flannel, absorbent cotton-wool is used, one layer next the skin, the other, dipped in plaster cream, moulded on the outside of this.

FRACTURE OF THE TIBIA

The shaft rarely gives way by itself except as the result of direct violence; the internal malleolus, however, may be wrenched off; the tubercle torn away by sudden contraction of the quadriceps; and the spine, and even the head of the bone, split in two by the tension of the crucial ligaments in violent twists of the knee. As a rule there is no difficulty in the diagnosis; but if the line of separation is exactly transverse, especially in the upper part of the bone, and if there is much ecchymosis, so that it is not possible to feel the edge of the crest, it may be necessary to wait for some days, treating the case as a fracture in the meantime. The deformity so long as the fibula is intact cannot be serious, though there is sometimes a certain amount of rotation at the lower articulation. Union takes place readily; but in a few cases, in which the patient, in spite of the pain, has continued to use the limb, a false joint has formed, the fibula becoming bowed and greatly strengthened, so as to take more than its share of the weight. In all cases of fracture near the upper extremity of the tibia the condition of the knee-joint must be carefully examined, as it is not uncommon for fissures in the bone to run upwards as well as downwards in the shaft.

FRACTURE OF THE FIBULA,

on the other hand, is of very common occurrence. It may be due to direct or indirect violence: in the former case the situation of the fracture depends upon the locality of the force; in the latter, when the foot is twisted round between the malleoli, it generally takes place at the weakest spot, two to four inches above the ankle-joint; sometimes, however, it is higher up, under cover of the muscles, and occasionally in both places at the same time. In many instances the diagnosis is very difficult; and it is not improbable that fracture is present, without being detected, in a large number of sprains. A slight degree of mobility and crepitus can generally be made out by pressing alternately with the thumbs side by side over the seat of injury, or by forcibly twisting the foot: deformity is exceptional in uncomplicated fractures. In other cases the only sign is the loss of spring when the bones are squeezed together; the fibula yields and gives instead of recoiling; or ecchymosis make its appearance days after the accident; or there is one spot, at a distance from the apparent seat of injury, very tender on pressure; and it is of unusual significance if this spot remains constant when the bones are squeezed together higher up or lower down.

Fractures of the head and neck of the fibula are far from common; but they sometimes occur from direct violence, or from muscular action, the tendon of the biceps, and the external ligament combined, tearing the upper part off from the rest. In many of these cases the peroneal nerve is injured too.

Complications. *Pott's fracture.*—Fracture extending into the ankle-joint may be caused in various ways. The most common is violent eversion of the foot: the astragalus is twisted round in its socket; the external malleolus is forced outwards until the fibula gives way and breaks inwards towards the tibia; and the internal lateral ligament is stretched until it either tears across itself, or drags off part of the internal malleolus (fig. 156). If the force continues after the bone is broken, or if the patient tries to walk, the foot is displaced to such a degree that a kind of dislocation (Pott's fracture) is produced. In very severe cases the interosseous ligament between the tibia and fibula is torn as well, or a portion of the tibia is split off (fig. 158); in the worst of all the displacement is carried so far that the whole of the foot and the external malleolus are displaced to the outer side of the leg (Dupuytren's fracture).

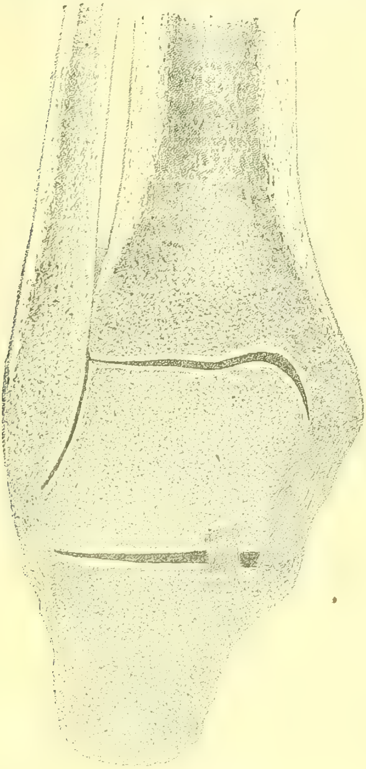


FIG. 156.—Eversion of foot, forcing fibula inwards, and throwing strain on internal lateral ligament.

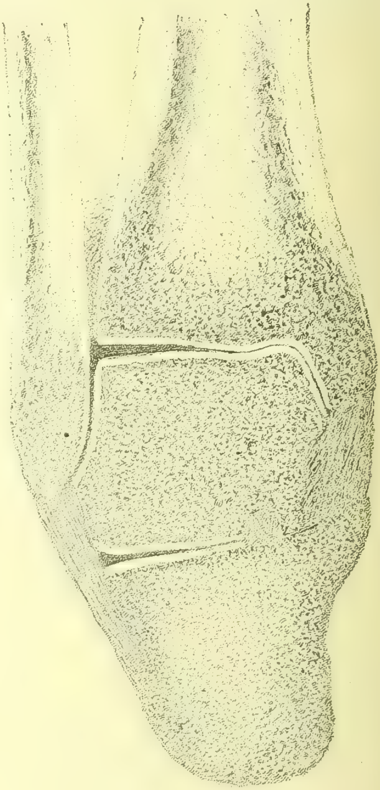


FIG. 157.—Inversion of foot, forcing fibula outwards.

Forced inversion causes an injury of a similar character; only the strain falls upon the external lateral ligament, and the lower end of the fibula is pulled inwards until the bone breaks at its weakest spot (fig. 157). If the force is not exhausted, the internal malleolus or the lower end of the tibia gives way as well.

In other cases a fissure, starting from an oblique fracture of the tibia, runs down in the substance of the bone until it traverses the ankle-joint; or the tibia and fibula are separated from each other and the astragalus driven up between them; or both malleoli are broken off so that the foot can be moved freely in all directions upon the leg. These complications, however, are much more rare. As a rule the diagnosis does not present any difficulty; the character of the displacement and the shape of the swelling (for the synovial sac becomes distended with blood at once) can be recognised immediately; but in every case of fracture of the fibula by indirect violence, if there is the least tenderness on pressure over the internal malleolus, the patient should be warned that the joint is very likely to be stiff and weak for a considerable time after the accident. Most of these fractures can be put up at once, either in the Bavarian splint or in some modification of it; the foot falls into its natural position as soon as the muscles are relaxed. But every now and then cases are met with in which the deformity obstinately returns, and one or two are recorded in which, in spite of division of the tendo Achillis, it could not be reduced at all, probably from splintering of the bones and inability to disengage the fragments. For such as these, either an outside splint with a foot-piece, as already described, or Dupuytren's (fig. 159), answers better. The latter consists of a straight piece of wood about four inches broad, and sufficiently long to reach from below the foot to above the knee. The padding is doubled opposite the malleolus and does not extend below it. The splint is first bandaged to the inner side of the leg (the knee being well flexed) and then the foot is drawn over the projecting pad and secured to the lower part by a figure-of-eight, no turn of which must be allowed to come above the ankle. A foot-piece corresponding to the sole may be added with advantage.

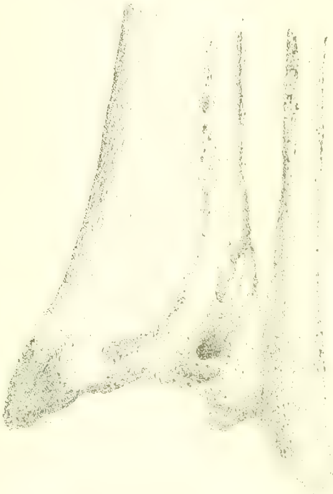


Fig. 158.—Old united fracture through lower end of tibia with separation of the two bones, the interosseous ligament having remained intact.

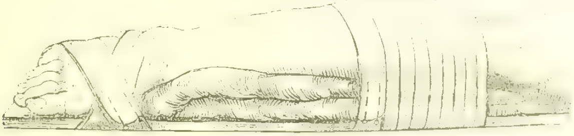


Fig. 159.—Dupuytren's splint.

In all these fractures the greatest care is necessary to prevent any drooping of the toes or carrying backwards of the foot; if the distance between the malleoli is altered in the least, whether it is increased or diminished, lameness and serious disability are sure to follow. Passive motion should be commenced in three weeks, and to allow of this it is essential that the apparatus used should either be laced up or so arranged that it may readily be taken off and on. Stiffness, œdema, and a sense of weakness about the joint are very common after-troubles, and must be met by massage, galvanism, friction, and shampooing. If the internal lateral ligament has given way and the weight of the body is allowed to fall too soon upon the injured part, an obstinate form of flat-foot may result.

Separation of epiphyses.—This is more common at the ankle than at the knee: in the latter situation it has been produced by forcibly attempting to straighten a case of genu valgum; and when the cartilage has been softened by neighbouring inflammation partial displacement is not rare. The lower epiphysis of the tibia is sometimes separated in a violent sprain of the ankle-joint, and this may be followed by impaired growth. When this occurs, the axis of the bone appears to be altered; the internal malleolus remains small; the fibula becomes much stronger, so as to support some of the weight of the leg, and is bowed outwards; and the external malleolus grows so much longer and larger than the other that the sole of the foot is turned inwards.

Wounds of arteries.—The anterior and posterior tibial arteries may be injured in simple as well as compound fractures; and the former may be torn as it passes between the bones, even when the seat of injury is some distance off. If the skin is unbroken, and the soft parts are not too much crushed, hæmorrhage from the anterior tibial can generally be checked by pressure; either the blood is absorbed and the artery closed, or a traumatic aneurysm forms, to be dealt with later on. When the upper part of the posterior is torn this rarely happens: as a rule, the swelling is so great that the collateral circulation is cut off, and the foot soon becomes cold and gangrenous; or it may hang in the balance for a day or too, and then require amputation. In one or two cases, however, in which the foot retained its warmth, ligature of the femoral has been successful, and compression might very reasonably be tried. In compound fractures, either both ends must be tied (and, owing to the extent of the injury and the retraction of the vessels, this operation is very often impossible); or the limb must be amputated. Wound of the posterior tibial at its lower part is an exception: in one instance, in which the ends could not be found, I succeeded in saving the limb by applying pressure, at the expense of a small superficial slough.

COMPOUND FRACTURES OF THE LEG

Owing to the superficial position of the bones, these are very common. Many, fortunately, are slight, the skin being merely punctured from beneath by one of the pointed ends, through carelessness in carrying the patient, or from his attempting to stand. These should be sealed at once and covered with iodoform, the bone, if it is still projecting, being first thoroughly cleansed with corrosive sublimate or some other antiseptic. Sometimes it is necessary to enlarge the wound a little or cut off a protruding spike.

At the opposite extreme are those injuries caused by direct violence, where the bone is so crushed and the soft tissues so disorganised that it is clearly hopeless trying to save the limb.

Between these two every grade is met with, and the question of treatment must be decided in each case, first by the age and constitution of the patient (especially the condition of his arteries and kidneys); and then by the amount of injury done to the limb and the complications that are present. The arteries must be examined first; if they can be felt pulsating, and if the skin is not stripped up too far, an attempt may generally be made to save the limb. The wound must be explored with the finger, enlarged if need be, and thoroughly washed out with an antiseptic. Loose splinters must be removed, and if the ends of the bone are bared of their periosteum, or so jagged that they cannot fit, they may be resected and sutured together. Then dependent openings must be made for drainage, all oozing stopped, the wound dressed with some absorbent material so that no fluid can collect, and the limb arranged upon an interrupted splint with pads covered with oiled silk.

If no pulse can be felt in the foot below, the line of treatment must be determined by the warmth of the skin and the amount of sensibility it retains. Next to the arteries, the condition of the skin is perhaps the most important; if it is destroyed over a large area, or if it is stripped up so that it is in danger of sloughing, the chance of saving the limb is immensely diminished; and even if this is accomplished it often happens that such an obstinate degree of œdema and ulceration persists, that the limb is not only useless but a constant source of danger and annoyance.

Everything depends upon the next few days. Sometimes, in spite of every care, the foot becomes colder and colder, the skin more dusky, and the sensibility less. Too much has been tried, and local traumatic gangrene is setting in. The only hope then lies in immediate amputation; the part cannot be kept aseptic; the sloughing is sure to spread, and it will not stop at the seat of injury. If the patient is young and healthy, there is a fair amount of hope still, provided the operation is done at once; if old or broken-down, so that the gangrene is rather the result of impaired vitality than of extensive injury, the prognosis is as bad as it can be.

Sometimes, on the other hand, acute inflammation sets in and rapidly becomes diffuse; the temperature rises, the skin becomes hot and burning, and intense fever, with perhaps delirium, follows. The leg is red, glazed, and immensely swollen; the discharge from the wound is offensive, and soon becomes profuse; the swelling rapidly extends up the thigh, especially on its inner side, and the neighbouring lymphatic glands become enlarged. The extravasated blood has decomposed; the poison is pent up, unable to escape, and may infect every tissue in the leg—skin, cellular tissue, periosteum, medulla, lymphatics, and even, perhaps, the veins. The issue depends upon which is the stronger, the irritant or the tissues; if the former, hopeless gangrene sets in and the patient is almost certain to die from acute septicæmia. If the latter, a wall of vascular lymph is gradually formed, and the poison shut off. Even then the course is not always straight. Cellulitis, requiring incisions to be made all over the leg, may set in, leaving the limb almost useless; necrosis, sometimes involving a large portion of the bone, is almost invariable; phlebitis and pyæmia may occur at any time; the inflammation may involve the neighbouring joints, either by direct extension or by spreading along the lymphatics into the synovial cavity; and the patient, if he survives the immediate dangers of septicæmia and pyæmia, may sink, later on, from exhaustion. Amputation, so long as the fever continues high, is practically hopeless; when the temperature begins to drop of a morning—when the tissues, that is to say, are just beginning to gain the upper hand—a favourable moment can sometimes be seized; until this occurs, all that can be done is to meet the symptoms as they arise.

Fractures of the Bones of the Foot

The posterior extremity of the os calcis is sometimes torn off by the tendo Achillis; and occasionally the body of the bone is crushed to pieces by falling or jumping down upon the heel. The astragalus may be broken in the same way and at the same time; or the neck may be twisted off in violent wrenches of the foot. Very often the bone is partially displaced. The existence of the fracture can generally be made out without difficulty, but it rarely happens that an exact diagnosis as to its seat and direction is practicable. The fragments should, in all cases, be manipulated as much as possible into position while the patient is under an anæsthetic, and then fixed with a plaster bandage. Passive motion should not be delayed for more than ten days or a fortnight, for fear of permanent stiffness of the ankle.

Compound fractures of the bones of the foot are common, but no definite rules can be laid down as to their treatment. In any operation the tread of the sole should be interfered with as little as possible; and it must always be remembered that stability is the first consideration.

Section III.—Diseases of Bone

ATROPHY

In old age the bones undergo a natural process of wasting, the central canal enlarges and encroaches on the cancellous tissue at either end; the compact portion of the shaft becomes thinner and thinner, until in some cases it is scarcely capable of sustaining the weight of the part, and the medulla is replaced by fat. The same thing may occur from prolonged disuse, as, for example, in cases of old joint-disease (fig. 160), and must be remembered in the reduction of old dislocations.

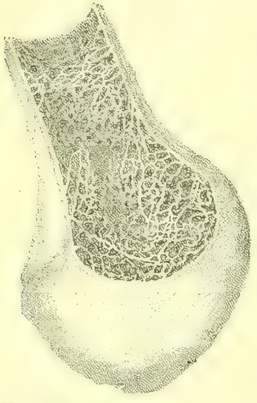


Fig. 160.—Atrophy of bone; vertical section through lower end of femur.

Gradual absorption of bone, as of other tissues, is caused by constant pressure. An aneurysm, for example, may perforate the sternum or eat away the bodies of the vertebræ until the strength of the spinal column is seriously impaired. The blood-vessels are compressed, the bone wastes away, and though the compact layer is to a great extent retained, the cancellous tissue is more or less exposed.

Arrest of growth is not uncommon as a consequence of rickets, hereditary syphilis, and other affections of the growing portion of the bone during childhood. Not only is the length of the bone less than natural, but sometimes, as in the case of the pelvis, there is an arrest of development as well. The same thing may occur from injury.

HYPERTROPHY

True hypertrophy may be congenital, the bones being involved together with, and in the same proportion as, the other tissues of the part; or it may arise from over-use, as a measure of compensation; the fibula, for example, being immensely strengthened, without undergoing any material change of proportion, in cases of partial or complete loss of the tibia.

Chronic inflammation not unfrequently gives rise to great alterations in size; but in this case the structural details of the bone undergo modification at the same time. In hereditary syphilis, for example, and in ostitis deformans, the bones often increase in length as well as in circumference, but on section the normal proportion of compact and cancellous tissue is not preserved. Increase of length from chronic inflammation, affecting the epiphysial line during the growing period, is still more common.

INFLAMMATION

The changes that take place in inflammation of bone are similar to those that occur in inflammation of other tissues; the apparent difference is due to the presence of a solid framework which plays an entirely passive and secondary part.

In compact bone the active vascular tissues lie partly on the exterior (the soft layer of the periosteum), partly in the central canal (the medulla), and to a much smaller extent in the substance of the bone itself, in the Haversian canals and the lacunæ. Inflammation may commence in any one of these, as periostitis, osteomyelitis, or ostitis, and although it never remains confined to one, but very soon involves the whole, it is often so much more marked in one than in the others that they may well be described as separate affections.

In cancellous bone, on the other hand, interstitial osteomyelitis or ostitis is practically the only form; there is no central canal, the medulla is distributed evenly through the whole, and although there is a periosteum, the layer of compact tissue which it supports is so thin that, even if an affection begins distinctly in one part, the rest of the bone becomes involved almost at once.

Pathology.—The pathological changes are the same as in the other tissues of the body; hyperæmia, dilatation of the blood-vessels, and increased rapidity of the flow, followed at a later period by stasis, if the attack is sufficiently acute. Lymph pours out through the walls of the vessels, the tissues become engorged and swollen (so far as they can, for therein lies the difference), the matrix becomes softened (if there is time), new blood-vessels are formed, the amount of exudation continues to increase, and at length periosteum and medulla are replaced by layers of soft, exceedingly vascular lymph or granulation-tissue, as deep and as thick as space will allow.

The subsequent course depends upon whether the inflammation is acute or chronic, and whether the portion of bone involved is compact or cancellous.

1. Acute Inflammation

When connective tissue is inflamed, the intercellular substance rapidly becomes softened (unless it is a sheet of very dense fascia), the vessels can expand and enlarge in all directions, and there is scarcely any limit to the amount of lymph that can be poured out. This is not the case in bone, especially when it is compact. It is true that as soon as inflammation commences the osseous framework begins to change in a similar way; it gradually becomes softened and eroded on its surface (whether under the periosteum, round the medulla, or in the Haversian canals) and special multinuclear cells to which this function is assigned (osteoclasts) are found in all these places, lying in little recesses (Howship's lacunæ) which they have eaten out for themselves: but, while fibrous tissue can soften and yield at once, it takes time in the case of bone, and consequently, if the attack is acute, either stasis occurs, without the possibility of any collateral circulation, or the blood-vessels become strangled in their own canals by the exudation around them. In other words, as in carbuncle at the back of the neck, if inflammation is acute, the circulation is stopped, the tissues perish, and gangrene (necrosis) occurs.

In compact bone this is the rule. Acute inflammation, if it is not followed by immediate resolution, ends in necrosis. If the periosteal surface is involved (*acute periostitis*), the sequestrum, as it is called, is superficial; if the medulla (*acute osteomyelitis*), it is central and tubular in shape, formed from the layers that immediately line the canal; if both together, the whole shaft perishes (*total necrosis*).

In cancellous bone, where the spaces are larger and wider, necrosis is more rare; the vessels have more room, dilatation and exudation are possible, and there is less solid bone to be absorbed; but if the inflammation is so intense as to cause thrombosis or stasis over any extent, the result is the same, and as a matter of fact small rounded sequestra of cancellous bone are not uncommon in the centre of suppurating foci.

When a sequestrum is formed, the dead portion acts as a constant irritant until it is separated and thrown off by a process of rarefying ostitis; so that an acute attack of inflammation causing necrosis must be followed by a chronic one.

2. Chronic Inflammation.—Rarefying Ostitis

When the exciting cause is not an acute one the bony trabeculæ have time to soften; the amount of exudation increases, more vessels are formed, the spaces enlarge, the solid walls that surround them are removed little by little, and the affected portion of bone becomes open and porous. Compact tissue becomes cancellous, cancellous tissue so soft that it can be cut with a knife.

If this commences on the outside the periosteum becomes softer, thicker, and more vascular, the tough fibrous layer is lifted up from the bone beneath by masses of newly formed lymph (forming, if the bone lies immediately under the skin, what is commonly called a *node*); and if it is torn off, it leaves a surface that is not white and smooth, but rough, uneven, covered with little bony spicules, and dotted all over with minute openings (fig. 161). If the medulla is involved first, the changes are essentially the same: the old spaces are enlarged, new ones are formed by the disappearance of the partitions, and the medullary canal is filled with soft masses of vascular granulation-tissue.

The simplest type of chronic inflammation is seen in the process by which a necrosed portion is separated from the rest. The living bone all around becomes more vascular, the Haversian canals expand and become filled with lymph, the solid matrix next to the sequestrum is absorbed and replaced by granulation-tissue, and by degrees a line of demarcation cuts it out. The necrosed part is detached by the irritation it causes, at the expense of the living bone around it, and lies in a cavity, the walls of which are formed everywhere of granulation-tissue, springing from rarefied bone. In the majority of instances suppuration occurs, but it is not an essential part of the process.

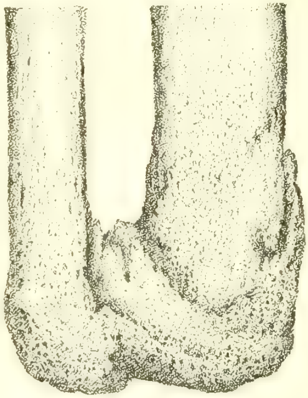


FIG. 161.—Chronic inflammation of bone. The tibia and fibula from an old amputation, showing excessive vascularity with great production of new bone.

The subsequent changes depend partly upon the intensity and persistence of the cause, partly upon the strength of constitution of the patient.

(*a*) *Resolution.*—When the irritant is but slight and transient, resolution soon begins: the vascularity diminishes, some of the lymph becomes absorbed, the rest is organised, and in a short time the natural condition of the part is perfectly restored. The changes that take place after a simple fracture are a very good illustration.

(*b*) *Persistence* (*caries sicca or fungosa*).—In other cases the process continues without altering in character, until the whole of the bony framework is absorbed; nothing but a mass of soft granulation-tissue is left. The whole body of a vertebra may be removed in this way, so as to cause angular curvature of the spine, and the phalanges of a finger may simply disappear until the nail rests upon the head of the metacarpal. Extreme forms of this kind appear usually to be associated with tubercle, but there is no caseation. Dead bone may be absorbed as well as living; a sequestrum, so long as it is surrounded by living granulation-tissue (not by pus), gradually diminishes in size, being eroded and eaten into from the surface in the same way as an ivory peg.

(*c*) *Organisation* (*osteosclerosis*).—In some diseases, rheumatism for example, and not unfrequently syphilis, the vascular granulation-tissue becomes organised and converted into bone. This is especially prone to happen at a little distance from a focus of suppuration, and not uncommonly extends all round and encloses it (fig. 163). When it occurs in the substance of a bone, the trabeculæ, instead of softening and disappearing, become hardened and thickened; the cells that lie upon their surface are incorporated with them; the spaces left between, filled with soft granulation-tissue, become smaller and smaller; the Haversian canals are narrowed; and at length the affected portion of the bone is converted into a dense, hard, and heavy mass like ivory. If the medulla is involved, the canal simply disappears: it is completely filled in; if the periosteum, the changes are essentially the same: layer after layer of lymph is thrown out upon the surface and converted into bone, until the natural exterior of the shaft is coated over with a ring of newly formed osseous tissue, and the thickness of the wall is doubled or trebled (fig. 164). The so-called expansion of bone over central sequestra or sarcomata is produced in a similar way: as the interior becomes hollowed out and weakened, the periosteum on the outside maintains the strength of the part by the new bone it forms, until perhaps the whole of the original shaft disappears, and a new shell with a much larger cavity is developed in its place (fig. 173).

For the most part this change is to be regarded as reparative in character, but sometimes it leads to consequences which, instead of being beneficial, make matters worse. One has been mentioned already: a suppurative focus in the cancellous end of a long bone may be completely locked in; layer after layer of dense osseous tissue is formed around it until escape is impossible; but unhappily this process is rarely uniform; the periosteal surface becomes thickened (fig. 163), but not the articular, so that if a joint is near and suppuration continues, the pus is almost certain to work its way into the cavity and lead to destructive arthritis.

In other cases the Haversian spaces and the medullary canal become so constricted that the amount of blood going to the part is scarcely sufficient to maintain its life, and the least irritant causes necrosis. Sometimes apparently none is required. Paget has described a form of *quiet necrosis* in which there is no suppuration, or exceedingly little; the sclerosis simply continues until the vascular canals are obliterated and the central portion of the affected area dies. The sequestrum formed in this way may take years before it is completely detached. Meanwhile it acts as a continual irritant, the bone around is kept in a state of chronic inflammation, and either rarefying ostitis sets in, and the strength of the part is so much impaired that spontaneous fracture takes place, or it becomes denser and harder, and layer after layer of new bone is laid down, until at length the circumference is doubled. In either case, the diagnosis from malignant disease is exceedingly difficult, and not unfrequently the actual condition has only been recognised after amputation.

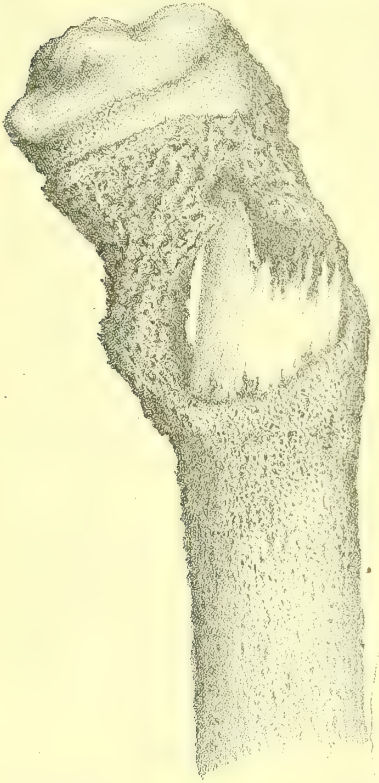


FIG. 162.—Suppurative periostitis and osteomyelitis of tibia: the sequestrum, which is locked in, involved the whole thickness of the bone. Owing to the constant irritation near the epiphysial line the upper end of the tibia has grown obliquely.

Syphilitic inflammation of bone, especially the inherited form that occurs at puberty, is often followed by an extreme degree of sclerosis. The whole of the shaft, generally of the tibia, becomes enlarged and condensed; superficial sequestra form, probably from gummatous infiltration of the periosteum; and, owing to the extreme density of the bone beneath, it may be years before they are loose enough to be removed. The same thing is not uncommon after acute necrosis of the lower end of the femur; the sequestrum, especially when the posterior surface is involved, may remain adherent for the rest of life.

Closely allied to this are the changes in shape and size, as well as in density, which are sometimes met with in adults. In most instances (ostitis deformans, for example) they are the result of some general disorder of nutrition, and the whole skeleton is affected more or less; but occasionally alterations of a similar description—elongation, curving, irregularity of the surface, disappearance of the medullary canal, and condensation—are produced by purely local irritants.

In children, before the epiphyses have united, the growth of the bone in length, as well as the shape, may be very seriously affected by premature condensation. Ossification sets in, the epiphysis is joined to the shaft before full size is reached, and development is stopped. In other cases, exactly the opposite result follows; owing to the greatly increased vascularity of the part unnatural growth takes place and the bone becomes very much elongated. This may occur on one side of the bone only, so that the axis of the limb is seriously distorted (fig. 162); or in one of a pair and not in the other, in the tibia for example and not in the fibula, so that the neighbouring joint is rendered almost useless.

3. Caries

Of this there are two varieties: (*a*) simple or non-specific, in which pyogenic organisms only are present; and (*b*) specific, in which the destruction is due to tubercular, syphilitic, or leprosy germs, with or without the others. In the first variety the granulation-tissue breaks down into pus directly; in the second fatty degeneration and caseation set in first, and suppuration is a complication. In both the trabeculæ that are not absorbed are deprived of their nutrition and perish; and small fragments of dead bone drop off into the fluid that surrounds them. When the inflammation is acute, the sequestra may be of some size (*caries necrotica*); ordinarily they are very minute.

Caries may occur either on the surface of compact bone or in cancellous tissue. The former is most often met with in connection with syphilis. A gummatous deposit forms in or under the periosteum, softens and breaks down, leaving a foul-looking ulcer, the floor of which is formed of roughened bone, soft, and as pyogenic germs are always present in sloughing gummata, covered over with pus. Underneath, if this is scraped away, there is a border of rarefying ostitis; and, as a rule, farther off, one of sclerosis, the difference depending upon the diminishing intensity of the irritant.

In cancellous tissue it is much more common. The carpus and tarsus, the bodies of the vertebræ and the articular ends of the long bones, are the favourite places. It begins as rarefying ostitis; the Haversian canals become dilated; the trabeculæ are absorbed, all the spaces enlarge, and very soon the affected part is converted into granulation-tissue with only a few bony spicules left. If the cause is a transient one, resolution or organisation follows, and the damage is repaired. If, on the other hand, living organisms are present, and they continue to grow, the newly-formed lymph is killed, the solid tissues break down and become liquid, the trabeculæ that are not absorbed die and drop off as minute sequestra; and in a little while a cavity is formed, filled with fluid débris, and surrounded by a wall of softened, congested bone.

(*a*) *Simple caries.*—In a chronic abscess of the cancellous end of one of the long bones, such as is sometimes caused by injury (fig. 163), all these changes may be found existing together, side by side. In the centre is a sequestrum; thrombosis occurred in some of the vessels at the time of the accident, the collateral circulation could not be established, and necrosis resulted. Around this is a cavity filled with pus, a few (but only a few) germs having reached it through the blood. The bone which originally occupied this space has been absorbed; the inflammation was not sufficiently severe to kill the part *en masse* as it did in the centre; there was time for rarefying ostitis to set in; the bony trabeculæ were removed; the granulation-tissue that replaced them melted away into pus; and an abscess-cavity resulted.

The wall of the abscess is lined with a so-called pyogenic membrane—in other words, vascular lymph or granulation-tissue, which has caused the removal of every particle of bone, and has been able to resist the action of the pyogenic organisms. Around this is a circle of rarefying ostitis, gradually becoming less and less characteristic as the distance increases. Close to the cavity there is only a bony spicule left here and there; it is nearly all soft tissue, continuous with that lining the abscess and furnishing by its death the pus that fills it. Farther away the proportion is reversed; and at length, quite on the outside, where the effect of the irritant is scarcely felt, organisation has taken place, the bone is hard and dense (sclerosed) and new layers are thrown out under the periosteum.

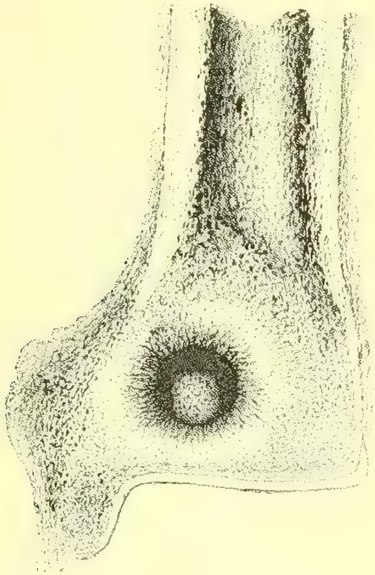


FIG. 163.—Diagrammatic representation of an abscess in the cancellous end of the tibia, showing a central sequestrum lying in an abscess-cavity with vascular bone around, and farther away sclerosis and a deposit of new bone.

These changes are the result of two forces: one is the destructive action of the irritant, aided by the pyogenic organisms; the other is the effort of the tissues to repair and limit the damage. The same may be seen when caries affects the surface of a bone, provided the patient is otherwise healthy: in the centre, where the irritant is most active, the destruction is complete; around the margins of the ulcer (for such it really is) and deep down under its floor, there is a deposit of new and dense bone.

(*b*) *Specific caries.*—This is nearly always due either to tubercle or syphilis: the other infective organisms are more rare, and the effects they produce not characteristic.

Tubercular caries is especially distinctive. It is marked out at once from all the rest by the entire absence of repair. So long as the tubercle is spreading, the inflammation is never confined, either by sclerosis or a deposit of new bone. The whole structure is light and porous; there is no evidence of organisation, no thickening under the periosteum or sclerosis in the cancellous spaces. The centre is filled with caseous débris or a thin oily fluid mixed with minute sequestra: around this is a layer of granulation-tissue studded with miliary tubercles, which constantly spread wider and wider, while they decay and caseate in the centre. If the nutrition of the bone improves, or that of the bacilli deteriorates, so that the former gains the upper hand and the inflammation ceases to be tubercular, encapsulation and sclerosis occur, as when the cause was traumatic. If, on the other hand, the bone-corpuscles are badly nourished or in a state of fatty degeneration (which is said to be common in tuberculous subjects) there is nothing to oppose the spread of the disease, and it continues until the whole is reduced to a periosteal shell, filled with caseous débris. There is no true suppuration unless the pyogenic germs enter as well as the tubercle-bacilli, and in sufficient number; if once they do, the destruction becomes infinitely more rapid.

Syphilitic caries presents no special features. It may occur by itself and cause the most extensive destruction (fig. 170), but suppuration is usually associated with it.

Causes.—Inflammation may be caused either by organised or unorganised irritants: the latter may be mechanical (tension or the presence of a foreign body), or chemical (mercury or phosphorus); the mode of action of the former is uncertain and perhaps not always the same.

1. *Mechanical injury.*—In wounds and fractures the bones, like other tissues, become inflamed if the parts are not kept at rest, if there is any tension or if there is a foreign body present, such as a sequestrum, and sclerosis or rarefying ostitis sets in, but not suppuration.

2. *Chemical poisons.*—Some of these, like mercury and phosphorus, are introduced directly from the exterior. Others, as in the case of gout and rheumatism, are in all probability the product of some perversion of nutrition. Whether certain other affections of bone, which are not so distinctly inflammatory in their character (such as ostitis deformans, rickets, and osteomalacia) are also due to chemical changes in the blood, is perhaps open to argument; but at least no clear line can be drawn between them.

3. *Infectious organisms.*—(*a*) *Non-specific.*—Inflammation of the most intense character may occur after amputations or compound fractures, especially if the medullary canal has been laid open; or by infection from the blood (acute suppurative periostitis, osteomyelitis, and epiphysitis), the germ entering either through some cutaneous boil, or, if the skin is unbroken, through the alimentary or respiratory tracts, and finding a suitable nidus for its development in the bone. It is not uncommon after the acute exanthemata, especially typhoid fever.

As in all forms of inflammation of bone in which necrosis or suppuration occurs, the attack does not cease when the primary cause has spent its energy; the sequestrum remains behind as a foreign body and acts as a constant irritant, keeping up chronic inflammation, until it is detached and the loss repaired.

(*b*) *Specific.*—Periostitis and interstitial osteomyelitis are exceedingly common in syphilis, both in the acquired and the hereditary form. The inflammation may be acute, occurring early in the course of the disease, affecting the periosteum chiefly and ending for the most part in resolution, or chronic, involving the bone as well, and often complicated by suppuration. Sclerosis and hyperostosis are more common in the hereditary form. Tubercle usually affects young subjects, and nearly always cancellous bones, though it may occur upon the cranium. Other specific organisms, such as those of leprosy and actinomycosis, are too rare to require special mention.

Secondary inflammation of bone, due to extension from structures near, is frequently met with. Ulceration of the skin, for instance, may extend into the substance of an underlying bone and lead to caries; or, in a poisoned wound of the finger, the inflammation may spread along the lymphatics to the tendon-sheath and the periosteum, and lead to acute suppurative periostitis.

Varieties of Inflammation

Simple Traumatic

Contusions occasionally give rise to an effusion of blood under the periosteum or in the cancellous tissue; but except in children it is rarely extensive. The sub-periosteal extravasation on the parietal bone in infants after difficult labour (*cephalhæmatoma*) is an exception. This may attain a very considerable size, though it is always strictly limited by the sutures, and may last for months before it is completely absorbed, the edges becoming hard and organised while the centre remains soft and semi-fluid. In cases of fracture the extravasation is more extensive, filling up the medullary canal and spreading into all the tissues around as well.

The subsequent changes are the same as in other tissues: the blood coagulates; the liquid portion disappears; the vessels dilate; lymph pours out through their walls into the remainder of the clot, and all the tissues around become softened and swollen. In other words, the tension and the extravasated blood have caused a very slight degree of inflammation.

(*a*) In the vast majority this is followed by *resolution*; the broken-down clot is gradually removed; the exudation is absorbed; the blood-vessels shrink to their normal diameter; and the structure of the part is completely restored.

(*b*) Occasionally *organisation* takes place, and the lymph becomes converted into bone. This is always due to some slight but persistent irritant; it may be a local one, as when organisation occurs round the margin of a cephalhæmatoma; more frequently it is constitutional, as in syphilis or rheumatoid arthritis. In these diseases the general nutrition is so perverted that if the tissues become inflamed, no matter what the exciting cause may be, the attack is not allowed to subside; it is maintained and made chronic by the constitutional complaint.

(*c*) In rare instances the death of the part of the bone that is injured takes place; thrombosis occurs, and if the collateral circulation fails necrosis results. In the soft tissues the dead part is removed by fatty degeneration. In bone what is known as *quiet necrosis* follows. A portion of the shaft perishes, acts as a foreign body keeping up a slight amount of irritation, and leads to the formation of dense and thick layers of new bone around, so that sometimes an enormous degree of enlargement is produced. Suppuration is a complication and not an essential feature; but generally the pyogenic organisms gain access to the injured tissue through the blood-stream, and a certain amount of pus is formed. If this occurs in the shaft of a long bone it is known as chronic osteomyelitis (fig. 164); if in the cancellous end, as chronic abscess of bone (fig. 163). Probably in these instances the tissues outside the immediate seat of injury are well nourished, the pyogenic irritants are few in number and capable of but little mischief, and sclerosis soon shuts them in.

Symptoms.—(*a*) *Simple acute inflammation* (*traumatic node*). The symptoms are rarely severe. If the bone is superficial the skin is a little raised, perhaps warmer than it ought to be, and adherent to the periosteum beneath; usually it is rather whiter than natural, owing to the way in which it is stretched; only when the inflammation reaches it does it become much reddened. It is always very tender on pressure; if there is any muscle attached to the injured spot the patient will not use it; and there is a constant dull aching pain which grows worse at night as the limb becomes warm in bed, and gradually subsides towards morning. In children there may be slight feverishness, but never such, in simple traumatic inflammation, as to excite anxiety.

(*b*) *Chronic inflammation; chronic ostitis, periostitis, or osteomyelitis; chronic abscess of bone.* The symptoms of all of these are of the same character, though they differ very much in intensity. The most striking is the constant dull aching pain, worse at night when the patient gets warm, and worse in wet weather or after exercise. In sub-acute attacks, or when there is an abscess shut in, it may be very severe. The whole bone is enlarged by expansion and the formation of new layers on the surface, though this often appears to be greater than it really is, owing to the condensation of the soft tissues over it. In periostitis the swelling usually involves only one side, and is irregular and nodular on the surface; when the cause is more deeply seated the outline is generally smooth and even. The skin rarely shows any change, though it may pit slightly on firm pressure if the bone, like the tibia, is subcutaneous. As a rule there is tenderness over the whole bone, but not unfrequently, especially in chronic abscess of the cancellous end, one spot is exquisitely sensitive; and occasionally it is a little reddened and puffy upon the surface. There is no local rise of temperature, unless the inflammation is nearing the skin, and as a rule little or no constitutional disturbance; but the muscles are not unfrequently wasted, and if the articular end of the bone is involved, the neighbouring joint always shows signs of synovitis.

Treatment.—Simple acute inflammation, as a rule, subsides rapidly if the part is kept at rest and the amount of blood flowing through it checked by elevation, cold, and lead lotion. Whether necrosis takes place or not depends upon the extent of the thrombosis and the amount of bone which has been deprived of its blood-supply. If, for example, stasis occurs in the diploe of the cranium, the whole thickness of the bone may perish, and there is great danger (if suppuration sets in) of the inflammation spreading to the meninges or the sinuses and causing pyæmia, as, for instance, in Pott's puffy tumour; if only the surface is affected, either there is no necrosis at all, the collateral supply maintaining the nutrition, or the sequestrum is superficial.

If the inflammation, instead of subsiding, persists and becomes chronic, the treatment must be guided by the cause. Sometimes nothing but osteosclerosis can be found to explain it: the inflammatory exudation, under the influence of a rheumatic or a syphilitic constitution, has undergone organisation; the whole bone has become hard and dense, and the seat of a chronic wearing pain. Sometimes, on the other hand, a sequestrum or a minute quantity of pus is locked in, either by the compact tissue of the bone itself or by layers of new bone thrown out under the periosteum, or by both together.

In the former case, when the cause is purely constitutional, iodide of potash and counter-irritants (iodine applied locally, blisters, and even the actual cautery) are the chief remedies, special attention being paid to the diathesis that is present.

In the latter, when the pain and swelling are confined to one part of a bone, or when, though the whole is involved more or less, one spot is distinctly more tender than the rest, more active measures are possible. Iodide of potash should be tried first and may give relief for a time, but if the symptoms persistently return, particularly if one spot in the skin is slightly puffy or œdematous, or if the neighbouring joint is liable to attacks of synovitis, the patient should be placed under an anæsthetic, Esmarch's bandage applied, and a free incision made down to the bone, through the periosteum, at the spot where the tenderness is greatest. If the part involved is the cancellous end of one of the long bones, a trephine should be applied and a circle of bone removed, until the soft cancellous tissue is exposed. If there is an abscess, free exit should be given to the pus, and the cavity should be thoroughly wiped out with an antiseptic, or if there is a suspicion that it is tubercular, stuffed with iodoform. If nothing is found, the surrounding bone may be explored by means of a drill. Sometimes the amount of pus is so small that its escape, mixed with bone-débris, is unnoticed. If, on the other hand, the shaft is the part concerned, the operation is essentially the same, but, instead of trephining, linear osteotomy is performed with a Hey's saw, the cut being carried down until the medullary canal is exposed. Even when nothing is found to account for the symptoms, they not unfrequently subside and disappear completely after the operation, possibly from the relief of the tension, possibly from the rarefaction and softening of the compact tissue that follows.

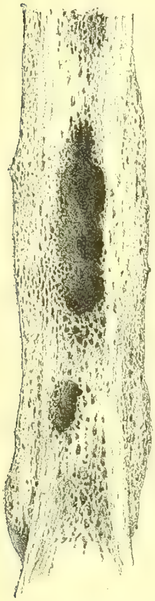


Fig. 164.—Chronic abscess in the centre of shaft of humerus (chronic suppurative osteomyelitis) leading to sclerosis and the deposit of new bone under the periosteum. The line of the old shaft can still be traced.

Phosphorus Necrosis

Inflammation of the jaws, of a peculiarly progressive and obstinate character, is not uncommon among those exposed to phosphorus fumes. So long as the teeth are absolutely sound they appear to enjoy immunity; but as soon as they become carious from any cause, inflammation sets in and rapidly spreads to the periosteum, the medulla, and the substance of the bone itself. The spongy part of the alveolar margin becomes exposed, the outer layers of the bone are eaten away, the surface is roughened, the medullary spaces filled with pus in which there is a number of minute sequestra, and the medulla itself is completely destroyed. Sometimes the disease remains limited to the alveolar margin; more frequently the sequestra refuse to separate, and it extends until the whole of the bone has perished and is detached from the periosteum. In the case of the lower jaw there is nearly always a deposit of new bone at the angle, where the severity of the inflammation is less acute; but it is of a peculiarly soft and spongy character, and adheres to the dead bone beneath, so that when the sequestrum is removed it nearly always comes away with

The symptoms may be of great severity. The gums become swollen; the pain is very intense; there is a profuse discharge of pus into the mouth, and partly from this constantly finding its way down into the lungs and the stomach, partly from the inability to take a proper supply of nourishment, the health soon begins to fail, the inflammation extends to the other parts of the face, and the patient becomes utterly worn out.

Very little can be done in the way of treatment until the sequestra become loose. Dead projecting fragments may be removed from time to time; the mouth must be kept sweet by constantly washing it out with Condy's fluid or some other antiseptic; abscesses may have to be opened, and the strength must be maintained as far as possible. In some cases the whole of the lower jaw, with the exception of the condyles and the attachment of the temporal muscle, can be removed. Reproduction usually takes place abundantly, and a massive bar of bone is developed in its place; but not unfrequently this atrophies again, and nothing but a fibrous band is eft to support the mucous membrane. It has been recommended, where possible, not to remove the teeth, in the hope that, if their attachment to the mucous membrane could be preserved, they might retain a certain degree of vitality and become sufficiently firm again to prove of use.

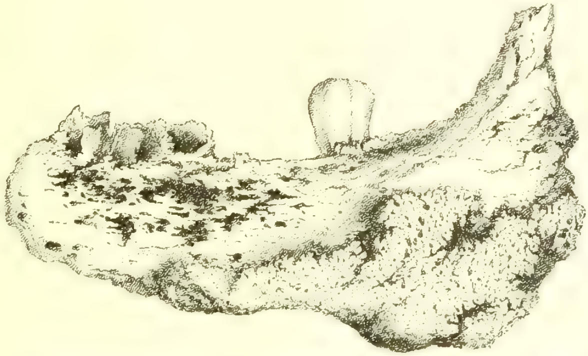


FIG. 165.—Phosphorus necrosis, most marked at the alveolar border, with a deposit of new and adherent bone at the angle.

MERCURIAL NECROSIS

Exposure to the fumes of mercury (as in a long since abandoned method of silvering glass), or its administration in excess, may cause necrosis either of the subcutaneous bones (the skull, sternum, tibia, or bones of the nose, or example) or of the jaws. In the latter case the origin is evidently ocal: the mucous membrane first becomes affected, especially around carious roots, or where there is an accumulation of tartar; then the periosteum and the lining membrane of the alveoli; the teeth become loose and drop out; and finally the bone itself becomes involved. At the present day it is ortunately very rare.

ACUTE SUPPURATIVE OSTITIS

Acute Necrosis

This may begin either in the medulla or the periosteum (*acute suppurative osteomyelitis* or *periostitis*); it is always the result of infection; it is much more common in children (especially in boys) than in adults, owing, in all probability, to the greater vascularity and more rapid nutritive changes in the bones during early life; suppuration sets in almost at once, and it is attended with the most intense fever, so that it may prove fatal within three or four days, with all the symptoms of general blood-poisoning.

A closely similar form occurs in infants, attacking the growing layer at the epiphyses (*acute epiphysitis*) and leading to suppurative arthritis; and occasionally after amputation, in which the medullary canal has been opened, an intense form of osteo-myelitis occurs from direct infection.

Acute necrosis is most often met with between the ages of eight and eighteen, and it nearly always affects the long bones, sometimes beginning in the middle of the shaft, but more often in the neighbourhood of the epiphyses. It may occur in perfectly healthy children, but fatigue and exhaustion are certainly predisposing causes. One of the most acute cases I have ever seen developed suddenly in the course of a chronic attack without its being possible to assign a reason. It has nothing to do with scrofula.

Causes.—There is usually a history of a blow or of some slight injury a day or two before; but although this may determine the locality of the outbreak, and perhaps (when the bone is superficial and the inflammation begins in the periosteum) assist the development of the poison by the extravasation it causes, it cannot be held responsible for more. The immediate agent is undoubtedly an infective germ which enters the blood, either from some cutaneous boil or through the alimentary or respiratory tracts, and which finds a suitable soil in the injured area. It is well known that in pyæmia abscesses are prone to develop at the seat of injuries, and that suppuration sets in around simple fractures if animals are fed upon putrid food; and it is possible a similar explanation will hold good for this; the germs are often present, but cannot develop without a suitable nidus having been prepared.

No specific organisms have been found in connection with the disease: the staphylococcus pyogenes aureus, which is met with in all forms of acute suppuration, occurs abundantly, so also does the staphylococcus pyogenes albus; sometimes there is a streptococcus too; and not seldom, especially in the worst cases, they are all found together; but they are in no way peculiar to it. In several instances acute necrosis appears to have been secondary to infection from boils; and it has been shown that the pus from a case of this kind rubbed into the skin of the forearm is capable of producing pustules and furuncles in abundance.

Morbid appearances.—In acute osteomyelitis the changes are practically confined to the medulla; outside, the periosteum is thickened and softened; the fibrous layer, especially near the epiphysis, is separated by a purulent exudation from the bare, smooth bone beneath, and the tissues around are swollen and infiltrated with lymph; but often, before there is time for anything further, the case proves fatal, with symptoms of the most intense blood-poisoning. The medulla itself disappears; the central canal is filled with purple extravasations and streaks of yellow pus; and in the worst cases, if the disease has lasted more than a few days, even the cancellous tissue at the ends of the bones is loaded with blood-stained pus, on the top of which is floating a scum of oily drops.

In acute suppurative periostitis this order is reversed; and if the tough fibrous layer gives way in time, so that the pus is not retained under such high tension, the morbid process spreads to the tissues around and causes more conspicuous changes. It usually commences on the shaft, in the neighbourhood of one of the epiphyses, especially on the posterior surface of the lower end of the femur. Possibly this is due to the extensive attachment of the gastrocnemius to the periosteum; a sudden contraction might tear it from the bone. The tibia, however, suffers almost as frequently; the bones of the upper extremity less often. Pus forms almost at once: nearly always it is mixed with blood, and very often there are oil-globules floating in it, coming from the medulla beneath. If it begins on the middle of the shaft, the whole of the periosteum may be stripped up within a few hours; if it is near one of the epiphyses it extends rapidly to the growing line, and then, being checked at this point by the much firmer attachment of the fibrous layer, turns inwards between the shaft and the epiphysis and spreads into the cancellous tissue. This peculiar limitation to the shaft is one of the most characteristic features of the disease.

How far the bone itself takes an active share in the inflammatory process is still an open question. Certainly, if the disease continues unchecked, the superficial layers are killed; and if it extends into the medulla the whole thickness perishes; but if free exit is given to the pus at once, even though the bone underneath is bare and white, recovery without any perceptible loss of tissue is not uncommon.

Left to itself the further progress is simply a question of destruction. The fibrous layer of the periosteum gives way; sometimes the tension to which it is subjected is so great that the whole of it sloughs. The pus, as soon as it gains the soft loose tissue outside, spreads in all directions, and forms huge diffuse abscesses between the muscles. The epiphyses become detached from the shaft; if this occurs at both ends the whole length perishes (total necrosis). The neighbouring joints become involved; synovitis always occurs from the mere presence of such intense inflammation near; not unfrequently acute suppurative arthritis follows; either the inflammation spreads along the fibrous layer until it reaches the reflection of the synovial membrane, or, as more commonly happens, the pus spreads in the soft medullary tissue of the epiphysis until it reaches the articular lamella underlying the cartilage of the joint: this gives way; a small round opening, like a minute trephine-hole is formed, and the synovial cavity becomes filled at once with intensely infective septic pus. Other tissues do not fare any better; diffuse cellulitis spreads up and down the limb; the skin becomes undermined; abscesses form and point perhaps a long way off, and at last symptoms of general pyæmia make their appearance. There is everything to favour such a termination: intensely infective pus; high tension; and inflammation of bone. Sometimes numerous metastatic abscesses form in all parts of the body, especially in the wall of the heart, causing purulent pericarditis; sometimes the constitutional infection is so severe that the result is fatal even before these have time to develop.

Repair.—If the case does not prove fatal from acute blood-poisoning within the first few days, the process of repair commences; the inflammation ceases to spread; the suppuration becomes limited; the tissues that have been killed are gradually detached, and organisation begins.

(*a*) In the most intense form, when the periosteum and medulla are both involved, the whole shaft perishes, and the destruction is too great for effective restoration. Fortunately, it usually falls short of this; the growing layer is left; new bone is thrown out; the sequestrum is gradually separated, and even if the shaft is destroyed from end to end and taken away, it is very fairly reproduced.

(*b*) Repair is most easy in periostitis. As soon as the tension is relieved, and the inflammation ceases to spread, the living bone beneath the sequestrum becomes more vascular; rarefying ostitis sets in; a layer of granulations is formed; and gradually the necrosed fragment is entirely detached. Farther away, where the effect of the irritant is not felt so much, the lymph becomes organised and new bone is formed (osteosclerosis). Similar changes take place on the side of the periosteum, only they have the effect of locking the sequestrum in, so that it can only be released by operation. The under surface, facing the dead bone, is converted into vascular granulation-tissue; in this organisation soon begins and a sheath of new bone is formed, covering in the sequestrum, and continuous above and below with that which is still living. At first, like all new bone, it is soft and porous, traversed by numberless little vessels running inwards from the surface, just as in callus (fig. 166); but by degrees, if the sequestrum is removed, it becomes harder and denser; and in proportion as this occurs the amount diminishes, until at length the gap in the old bone is filled with tissue, which in size, shape, and direction of blood-vessels, is practically the same as it was before. The sequestrum from a case of periostitis may always be recognised by its smooth external surface, and the rough worm-eaten part beneath, where it has been excavated and detached by granulations. In osteomyelitis this is of course reversed.

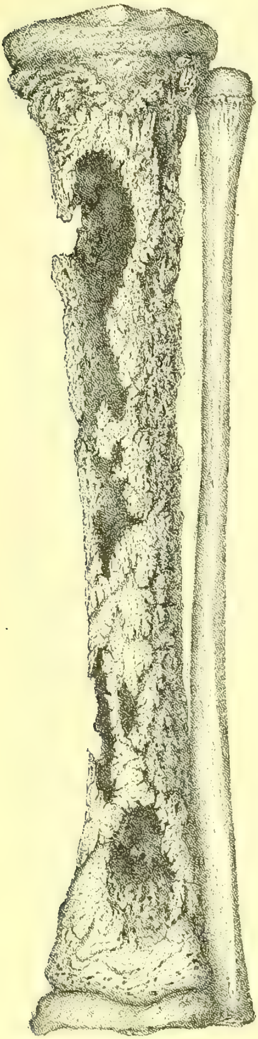


FIG. 166.—Acute suppurative periostitis and osteomyelitis (acute necrosis) of shaft of tibia from a child. The sequestrum has been removed, and the new shell, deficient in many parts where the periosteum sloughed (cloacæ), is left. The epiphyses are intact.

The amount of new bone thrown out depends (so far as local conditions are concerned) partly upon the intensity of the inflammation, partly upon the length of time the sequestrum is allowed to remain and act as a foreign body. In the most severe cases, the periosteum, like the compact tissue beneath, is killed at the first, and no new bone is formed: the shell is deficient over a great part of the gap, although there is usually a certain amount at either end. If this occurs in the tibia, the two extremities, provided the epiphysis have remained intact, sometimes form a connection with the fibula, and this, because of the increased weight it has to bear, becomes hypertrophied. If it is the femur or the humerus nothing can be done, except possibly transplantation: in one or two instances a bone has been built up by this. Even, however, in moderately acute cases portions of the periosteum usually slough, and deficiencies are left here and there in the new shell. These openings are known as *cloacæ*, and they serve as channels to convey the pus from the interior to the sinuses by which it is discharged through the skin.

Sometimes, when the tension has been relieved by free incision at once, no necrosis at all takes place; the bone is exposed, bare and white, but as soon as the pus has free exit the inflammation ceases, and the periosteum falls down on to its place again. Even in these, however, a very considerable amount of new bone is thrown out, leaving an osseous node which becomes absorbed very slowly.

(*c*) In acute osteomyelitis, if the blood-poisoning does not prove fatal, the same reparative changes take place; but in most cases restoration is much less complete. This arises from the way in which the sequestrum is locked in. If the periosteum and the outer portion of the compact tissue escape destruction, and if (as in chronic abscess) layers of sclerosed bone are formed around, the removal of the sequestrum becomes exceedingly difficult, no matter how insignificant the size. The longer the irritation lasts, the deeper it becomes buried; and in old cases the bone becomes hardened, rugged, and enormously thickened, over perhaps its whole length. Sequestra locked in in this way in early life often give rise to such persistent trouble that after many years of suffering the patient begs for amputation. It is not uncommon at the lower end of the femur: a discharging sinus is left on the outer or inner side of the limb; the bone is enlarged, hardened, and perforated with suppurating channels; the knee-joint from repeated attacks of synovitis is utterly disorganised; and the patient becomes a hopeless cripple (fig. 167).

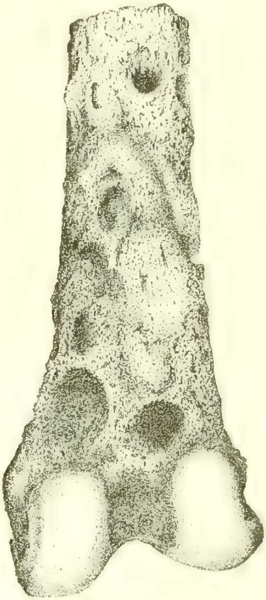


FIG. 167.—Chronic osteomyelitis of lower end of tibia. The section across the shaft was solid, and the medullary canal completely obliterated. Below, the bone is riddled with sinuses, which lead in all directions through it. It was amputated because of the disease of the knee-joint.

Symptoms.—The onset is usually very insidious, unless the inflammation develops in connection with an already existing attack of pyæmia; then it may begin with a rigor. The first and most prominent feature is pain, at the beginning flying vaguely all over the body, but soon settling down to one part, and becoming intense, especially at night. The least pressure or the slightest movement makes it simply intolerable; and the limb is kept absolutely rigid, as if it were paralysed, every contraction of the muscles pulling on the periosteum causes such agony. From the commencement the prostration appears unaccountably great; the pulse is small and quick; the temperature begins to rise at once; and in severe cases may reach 104° F. by the second or third day; the respiration is hurried; the tongue and lips dry; the skin burning hot; the pupils dilated and staring, and the face peculiarly dusky. Delirium soon sets in, especially at night, and by the third or fourth day the general aspect is that of the most intense blood-poisoning.

The local signs depend upon the situation. If the bone is superficial, as in the case of the tibia, the swelling can be detected at once; the skin soon becomes red and œdematous, and it is tied down to the periosteum beneath, so that it cannot move freely over the bone. On the other hand, when it is the femur, especially when the back part is involved, they are much more obscure: the skin remains white until pus has formed and worked its way near the surface; often it is whiter than natural, from the tension of the deeper structures beneath, with slightly enlarged veins passing over it; and no swelling can be distinctly made out. Usually, however, if the limbs are compared, the affected one looks more even in outline and more rounded than the other; the intermuscular depressions are partly filled up; and at the same time it feels more tense and firm, especially over the part where the pain and tenderness are most distinct. The temperature, too, is higher than that of the opposite limb; and if the inflammation is near a joint there is always a certain degree of synovitis. In osteomyelitis the difficulty of diagnosis is even greater than in periostitis; the constitutional symptoms are much more severe; the local signs much less distinct.

Later, when the pus has escaped from under the periosteum and spread into the tissues around, there is little or no difficulty. Dusky erythematous patches make their appearance upon the skin, the swelling becomes more distinct and localised, and deep-seated fluctuation is usually plain, especially if the patient is under an anæsthetic. The constitutional symptoms do not begin to subside until the pus has been evacuated.

When the medullary canal is involved the patient may sink from acute septicæmia before any local signs other than tenderness and pain have time to develop. If this does not happen various complications set in, according to the direction in which the inflammation can extend most easily. Acute suppurative arthritis is one of the most common, the inflammation spreading through the cancellous tissue of the epiphysis, or outside it along the fibrous covering. Separation of the epiphysis is another, causing deformity and a peculiar soft kind of crepitus when the limb is moved. In severe cases other bones may be involved, one after another being attacked at intervals of a few days in distant parts of the body; sometimes each outbreak is attended with a rigor, more frequently pain is the most prominent symptom, and the swelling is only detected on examination. Secondary attacks of this kind are rarely so deep or so extensive as primary ones. Fatty embolism is probably nearly always present, and finally pyæmia with metastatic abscesses may occur, the pericardium being involved with singular frequency.

Diagnosis.—Acute suppurative osteomyelitis or periostitis may be mistaken for typhoid or other acute specific fevers, especially when the septicæmic symptoms are very strongly marked and fugitive erythemata are present upon the skin, but careful examination can hardly fail to reveal a local cause. Occasionally it is mistaken for diffuse cellulitis, which, however, unless it is due to a poisoned wound, rarely or never occurs in children; and sometimes for acute rheumatic fever, especially when the lower end of the femur is involved on the posterior surface, so that the knee-joint is filled with fluid from the first.

Treatment.—*Division of the periosteum.*—Whenever there is a suspicion of acute suppuration in connection with bone, the patient should be placed under an anæsthetic, and an incision made through the soft parts and the periosteum on to the surface of the compact tissue, selecting the spot at which the tenderness is most marked. It is certainly not advisable to wait for a distinct sense of fluctuation; the pus may separate the epiphysis from the shaft, or detach the periosteum from almost the whole circumference, before it forms a sufficiently thick layer of fluid for this. The extent of the incision depends upon the condition of the periosteum; if it is only just separated from the bone beneath, a simple linear division may answer all requirements, free exit being provided for the effusion by means of a large drainage-tube. If, however, the separation is more extensive, the finger or a probe must be passed down to explore the surface thoroughly, so that counter-openings may be made where required.

Drainage of the medulla.—Sometimes the symptoms are relieved at once, the temperature falls, and it is clear the chief indication has been fully met. The limb must be kept perfectly quiet upon a splint, careful watch made that the opening does not close too soon or become valvular, and the periosteum will fall down on to the bone again, and very possibly there will be no necrosis. In other cases there is but a very short respite or none at all; and it is clear that farther exploration is required, that the separation of the periosteum was not the primary affection, but merely an indication of more deeply seated inflammation. This is especially likely to happen when the chief seat of tenderness is close to the epiphysial line, and when there is at the same time effusion into the neighbouring joint; under these conditions it is more than probable that the inflammation involves, if it did not begin in, the layer of soft vascular growing bone on the end of the shaft, and that, if it has not done so already, it will almost certainly spread to the medullary canal. It is this form of necrosis which, if left to itself, leads to death of the whole shaft and separation from the epiphyses at both ends. Under these circumstances, or if the epiphysis is already separated before the incision is made, the central canal of the bone must be opened and drained as well. When the connection is already severed the end of the diaphysis may be removed at once; with the medullary canal containing pus, with pus under the periosteum, and suppuration between it and the epiphysis, that part of the bone will certainly perish if it has not done so already. By this free drainage is gained at one spot; but that is not enough: an opening must be made into the central canal lower down on the bone, so that it may be thoroughly washed out. As a rule there is no difficulty in ascertaining the proper situation for this, for in such cases the disease is always far advanced, and either there is at some point extreme tenderness on pressure, or the periosteum is already detached and suppurating, the pus having worked its way out through the shaft along the course of the nutrient vessels. Then the cavity must be syringed out thoroughly with an antiseptic solution, the medulla itself removed as far as possible, iodoform dusted in, and a drainage-tube passed through. In one case in which this was done, by Jones of Manchester, the whole of the shaft of the humerus was drained, from its upper extremity where it faced the epiphysis to an opening made a short distance above the inner condyle.

Subperiosteal resection.—In the most acute cases, owing to the extreme rapidity with which the disease progresses, the time for this is already past. If the inflammation involves the periosteum only, free incision must be made down to the bone wherever fluctuation can be detected; if the medulla, and if the shaft is already detached at the epiphysial line, the whole of it had better be removed at once. This, which has been called *subperiosteal resection*, is most easily accomplished by dividing the bone in the middle with a chain saw; the two halves can then be readily twisted out.

It relieves the limb at once of what is practically a foreign body keeping up a very great deal of irritation; it lessens the danger to the neighbouring articulations, and it obviates the necessity for a long and tedious operation afterwards when the new shell of bone has been formed. An extra amount of care, of course, is required to support and protect the limb until the new bone is sufficiently firm.

Other treatment is of little or no avail. Iodine and counter-irritants are worse than useless; they simply waste valuable time, and the same may be said of iodide of potash. Quinine and antipyrin may be given when the temperature is very high, but they have little or no control over the disease itself. Afterwards, during the long period of exhausting and wasting illness which not unfrequently follows, the former with preparations of iron and cod-liver oil is often indispensable.

The limb should be kept at perfect rest upon a suitable splint, especially in those cases in which, owing to separation at the epiphysial line, or to the early removal of the sequestrum, the central support is lost, and sometimes it is necessary to maintain a slight degree of extension to prevent too much shortening. Cold applications, lead and spirit lotion for example, may be used at first; but as soon as there is an escape for the pus, warmth is more serviceable, as the object then is to encourage the discharge of the poison as far as possible.

Careful watch must be kept that the pus does not collect in the deep outlying recesses of the part and undergo decomposition, especially as when dead bone is present it is often peculiarly offensive. Counter-openings are often required, and drainage-tubes must be used freely. If the neighbouring joint becomes involved, it must be laid open thoroughly on both sides (and in the case of the knee behind as well), and freely irrigated. Even after this has happened the limb may be saved in exceptional instances; the upper epiphysis of the tibia, for example, has been removed, with some of the shaft, leaving a shortened limb riddled with sinuses, but capable of bearing some weight; nearly always, however, hectic and profuse suppuration set in; the cartilage becomes eaten out by granulations springing from the opposite bone; starting-pains make their appearance at night; the patient becomes exceedingly emaciated, and amputation is necessary to save life.

The subsequent progress, if pyæmia and other complications do not set in, is dependent upon the situation and the extent of the sequestrum. Sometimes, as already mentioned, it is completely separated within three weeks or a month: the line of demarcation corresponds to the soft vascular bone at either end, no time is required for absorbing compact tissue, and the whole shaft, even of such a bone as the tibia, can be extracted entire, leaving behind a great space lined with periosteum, which rapidly becomes filled with new bone. In other cases the time required is much longer, and in some exceptional instances it may be a matter of years, owing in all probability to the density and hardness of the surrounding osseous tissue. In young subjects the process is naturally much more rapid than in old, and it is somewhat quicker when the bones of the upper extremity are concerned.

Where the periosteum only is concerned and the sequestrum is small and superficial, it may separate of itself and be discharged through an opening in the skin, by what is known as exfoliation, without the necessity for any farther operation. This is not uncommon on the skull (after injury, for acute necrosis rarely affects the flat bones) and on the subcutaneous surface of the tibia. A line of rarefying ostitis gradually forms around the dead part, the compact tissue that immediately borders it becomes more and more open; at length it is completely absorbed, and the sequestrum is left resting on the surface of a bed of granulations. No new shell on the outside is ever formed by the pericranium to lock the dead bone in, and very often it is almost as defective on the tibia, owing to the thinness and the peculiarly exposed situation of the periosteum. As soon as the line of demarcation is complete, the sequestrum is held in merely by the skin, and only requires the application of a pair of forceps to remove it. In those cases in which no outside shell is formed, whether on the skull or elsewhere, the deficiency in the bone is rarely made good: the granulations gradually fill up the hollow and become organised, and the deeper layers become converted into bone, but the superficial part rarely passes beyond the stage of fibrous tissue. There is no doubt the periosteum is the main agent in reproduction, although it may not be the only one.

In central necrosis, on the other hand, or when a shell of new bone has been formed around the sequestrum, enclosing it and locking it in, extensive operations may have to be undertaken for its removal. The longer it is left after it has once become loose, the deeper it becomes buried and the more serious the changes that it induces, not only in the other structures near, but in the patient's general condition. The acute fever may have subsided long since and there may be only a slight evening rise of temperature; but this, if continued, especially if connected with bone, is very prone to end in either hectic or amyloid.

In the case of compact tissue it rarely happens that the living bone can separate itself from the dead under two or three months: total necrosis is an apparent exception, but in this the line of separation runs along the soft vascular growing layer. During this time the appearance of the limb changes very considerably. The heat and swelling of the acute stage gradually become less and less; the redness fades away, there is no longer such extreme tenderness on pressure, and the incisions, instead of gaping widely and giving exit to a mixture of pus and blood, gradually become contracted into narrow sinuses, lined with granulations, and secreting only a small quantity of purulent fluid, which oozes slowly from a tiny orifice surrounded by a button-shaped mass of little vascular buds. A probe passed into the centre of this sinks almost of its own weight down a devious channel, until, after passing through one of the cloacæ, it comes into contact with the sequestrum. The utmost gentleness must always be used: if it is forced in any direction, it is certain to catch somewhere against the walls, making them bleed, which they do with the greatest readiness, and causing pain.

The presence of a sequestrum must be gathered from the sensation the probe conveys: the hard, smooth surface and the clear ringing sound produced when a dead part is struck, differ completely from the soft gritty sensation of carious bone, into which the probe can be driven with ease, and from the firm but roughened surface of uninjured periosteum. The size must be estimated partly from the position and direction of the sinuses, partly from the extent of the enlargement and the range of the original attack. Whether it is loose or not is very often a matter for conjecture rather than for belief; occasionally it is possible to move it slightly by firm pressure; or, by introducing probes into two distant sinuses and pressing on them alternately, to convey a kind of shock from one to the other; but very often the sole evidence is the peculiar hollow note when the sequestrum is sharply struck, and the length of time that has elapsed.

The operation itself (*sequestrotomy*) naturally differs in every case. A time for it should always be selected when the patient's temperature is as even as possible; it very commonly happens when there is a sequestrum of any size that slight attacks of feverishness occur from time to time, each one marking the formation of a fresh abscess in the neighbourhood of the old inflammation. The limb should be raised to a vertical position for a few minutes, and an elastic strap buckled tightly round it; or Esmarch's bandage may be used. It is of great advantage not only to control the hæmorrhage at the time (and it is often very profuse) but to be able actually to see the condition of the bone. If the sequestrum is superficial, all that is necessary is to make an incision through the soft parts, either enlarging a sinus or connecting two that are close together, and twist it out with a pair of strong forceps; but when it is central a great deal of manipulation may be required. Sometimes the cloacæ are large enough to allow it to pass through: a very long sequestrum for instance from the tibia may, if caught fairly at the end, be extracted through a comparatively small opening. More often they have to be enlarged, or, like the sinuses on the skin, thrown into one, the intervening soft new bone being divided with a chisel or cutting-forceps, and, as far as possible, reflected without being removed. Occasionally, as in subperiosteal resection, the necrosed portion can be divided with a chain-saw and extracted in two halves.

After the removal a smooth cavity is left, lined with granulations which bleed freely as soon as the bandage is removed. This may be checked to a certain extent by washing out the interior with diluted tincture of iodine, or with very hot water, or by packing it with some antiseptic dressing; but unless the cavity is of very large size it is generally sufficient to bandage the limb carefully and keep it well raised: the bleeding only comes from capillaries which have been torn and have lost their support: it rarely happens that a vessel of any size is divided. Afterwards the wound must be washed out at frequent intervals with some antiseptic, as it is rarely possible to drain it effectually; and such an amount of blood, allowed to collect at the temperature of the body exposed to the air, might prove a serious source of danger. In a very few days the sides begin to fall in and contract; and as the granulations spring up and become organised, the amount of discharge grows less and less, until, in a comparatively very short time, the cavity is completely obliterated.

It is not always that the operation is so easy or is followed by such immediate success. In many instances the sinuses are surrounded by structures of such importance that only a very slight degree of enlargement is possible. Sometimes the sequestrum is not sufficiently loose, and only some of the superficial part can be chipped off or cut away; or it is so deeply buried that it cannot be extracted without almost cutting the bone in two. It is seldom that this happens as a result of acute osteomyelitis; but when the inflammation has been chronic (in quiet necrosis, for example, when a portion of bone near the centre perishes without causing suppuration) the compact tissue on the outside becomes thickened to such an extent that it is scarcely possible to make an opening of sufficient size. In other cases again the shell of new bone formed by the periosteum is defective, so that the limb is in great danger of what has been called spontaneous fracture. This may arise, as in subperiosteal resection, merely from the early removal of the sequestrum, and then in a week or two the limb becomes sufficiently firm ; but occasionally it is due to sloughing of the periosteum. If it occurs in the tibia, the limb may still be preserved and prove of use, the fibula being assisted by means of an artificial support ; in the femur, however, unless firm union can be obtained at the expense of the length of the limb, amputation must be performed.

All these difficulties combined are not unfrequently met with in necrosis of the lower end of the femur. The popliteal vessels, the external popliteal nerve and the synovial membrane of the knee-joint are all in danger ; so that, unless the abscess is actually pointing elsewhere, the incision must be made in the outer side of the limb in front of and parallel to the biceps tendon. The sequestrum is very often only partially detached, even after years ; if it is central it is exceedingly hard to extract before the knee-joint is involved, owing to the immense thickening and condensation of the bone above and around it ; if it is superficial and on the back of the bone (its usual situation), it is often in actual contact with the artery, owing to the absence or defective development of a proper periosteal sheath ; and instances of its having ulcerated through and caused fatal hæmorrhage are not unknown.

Other troubles may follow at a later period. A certain amount of chronic ostitis is not uncommon ; there are frequent attacks of tenderness and pain, especially at night ; the bone becomes immensely thickened and irregular in shape ; and occasionally, even after long intervals, residual abscesses form, probably from the slow decay and death of some of the lowly organised inflammatory exudation. Sometimes sinuses persist for years, surrounded by dense hard bone and discharging a thin purulent fluid from the granulations that line them. Minute sequestra not unfrequently become detached and slowly separate of themselves. In other cases the growth of the bone is arrested owing to premature ossification of the epiphysis ; or the neighbouring joint becomes stiff, and even at length practically useless from the repeated attacks of synovitis ; and finally in some cases, even after the limb has been saved, amputation becomes necessary at last, either because the part is useless, or to save the patient from hectic or amyloid disease.

Acute Epiphysitis

This name has been given to a variety of acute suppurative osteomyelitis which attacks the bony nuclei in epiphyses, or more often the growing layer between the epiphysis and the shaft. Not unfrequently more than one bone is involved, and probably it is always pyæmic in character, but nothing is known with regard to any exciting cause, other than that it is usually said to follow some slight injury.

The larger epiphyses (at the hip and knee) are most often affected, though the smaller ones are not exempt. In children it usually commences at the line of growth and spreads from there to the periosteum, or to the medulla, or to both together, leading to one of the worst forms of acute necrosis. In infants (and it is not uncommon within the first few months of life) it sometimes attacks the bony nucleus embedded in the centre of the cartilage, giving rise to what has been described as *acute arthritis of infants*. Suppuration sets in at once with the greatest intensity ; the articular end of the bone becomes hollowed out into an abscess-sac, and almost always the pus bursts into the neighbouring joint, destroying it completely. If the case does not prove fatal from blood-poisoning, or later from hectic and prolonged suppuration, the end of the diaphysis becomes united to the opposite bone, and the limb is left, more or less flail-like, shortened and incapable of its proportionate share of growth. The upper end of the femur, for example, as soon as the child bears any weight upon the limb, becomes displaced until the trochanter is on a level with the anterior superior spine.

Septic Osteomyelitis

Acute suppurative osteomyelitis, after compound fractures or amputations in which the medullary canal has been opened, resembles acute necrosis very closely, though it differs in a few particulars. The infection, for example, is direct, through the wound, not through the blood; the pus is usually very offensive, and the tension, owing to the fact that there is a certain though an insufficient means of exit, is not so high.

Minute sequestra are of common occurrence after amputations. A ring of bone on the end of a stump is killed by the saw, or by the separation of the periosteum, and after a time is detached without causing any constitutional disturbance, or giving rise to any more inconvenience than is due to the presence of a sinus. Sometimes the whole thickness of the bone perishes in this way just at the end. If, however, septic inflammation sets in and attacks the medulla, the result is very different. Masses of sprouting granulations project from the orifice; the central canal becomes filled with intensely infectious pus which cannot escape with sufficient freedom; the fever becomes exceedingly severe, the periosteum is stripped up from the bone, and if pyæmia does not set in and prove rapidly fatal, the whole thickness of the lower end of the bone, and the inner lamellæ for a very considerable distance higher, are killed. In this way the long tubular sequestra are formed which are sometimes extracted from suppurating amputation wounds. At the end, where the inflammation is most intense, the periosteum and medulla are both killed, and the whole thickness of the bone perishes; higher up, the periosteum and the outer layers, being farther removed from the central irritant, manage to survive, and the outer surface of the sequestrum is worm-eaten all over by the granulations which have cut it off from the rest; higher up still, the sequestrum grows smaller and smaller until it ends in irregular spikes formed from the layers immediately bordering the medulla (fig. 169). Above this, and on the outer surface of the bone, under the periosteum, organisation goes on all the time, and layers of new bone are formed, filling in the central canal, and sheathing the compact tissue of the shaft (fig. 168).

The symptoms and treatment are essentially the same as in acute infective osteomyelitis. The stump becomes red, glazed, and swollen; red lines run up the skin to the neighbouring glands; all the tissues on the inner side of the limb are thickened and œdematous; the edges of the wound separate from each other; sometimes the end of the bone projects, bathed in pus, with the periosteum detached from its outer surface and the medullary canal filled with masses of sprouting granulations; the amount of discharge increases; frequently it pours out when a probe is introduced; if it is retained in the least it becomes offensive and the pain excruciating. Usually the attack commences with a rigor; the fever, from the first, is extreme and the temperature exceedingly irregular; the pulse is rapid and bounding, the face flushed, the tongue dry and brown, and the skin burning hot. Delirium sets in very soon; sometimes there is profuse diarrhœa; in other cases rigors occur in rapid succession, and either osteophlebitis and metastatic abscesses make their appearance, or the blood-poisoning proves fatal before there is time for this.

Such cases used to be common after amputations through the shaft, and they still are met with in military surgery and where, from overcrowding or neglect of proper precautions, septic decomposition is rife: with perfect cleanliness and thorough drainage they ought never to happen. At the first indication, as soon as the condition of the medulla is suspected, the patient should be placed under an anæsthetic, the end of the bone freely exposed, and if the suspicion is confirmed and the cavity is found to be filled with offensive pus, the whole of the fungating suppurating mass that protrudes must be thoroughly scraped away. Then the canal must be washed out with an antiseptic by means of a long rubber tube or catheter, and filled with iodoform. In this way, the progress of the disease has several times been arrested without very extensive necrosis.

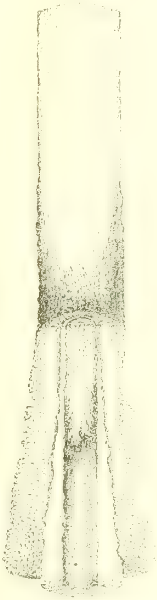


Fig. 168.—Section through bone after amputation, showing effects of septic osteomyelitis. At the end, medulla and periosteum have both been killed, and the whole thickness is dead; higher up, the periosteum, not being subjected to such tension, survived, and has thrown out a sheath of new bone; higher still, the medulla has been able to do the same.

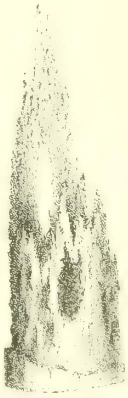


Fig. 169.—Tubular sequestrum from a similar case, showing the smooth external surface, where the periosteum was killed, and the rough, worm-eaten one detached by the granulations springing from the living bone.

In compound fractures this is hardly practicable, and the only course is speedy amputation before the disease has advanced too far and the constitutional symptoms are too marked. In the case of the tibia, it is probable that disarticulation at the knee would be the safest measure, so as to get well above the disease; but if the femur is in question this is almost hopeless. Amputation higher up may be tried, on the chance that the medulla at the seat of section is sufficiently healthy, and in one or two instances this has succeeded. Possibly this, combined with free drainage of the canal, would afford a better prospect than disarticulation at the hip.

Exanthematous Necrosis

Inflammation of the periosteum and the bone, followed by suppuration and, very often, by necrosis, is not an unfrequent complication of the acute exanthemata. Sometimes it occurs during the height of the attack, but much more frequently it breaks out during the period of convalescence. In some instances it is probably pyæmic, originating by infection from some of the sores or ulcers; but there is very often a history of its having followed a slight injury, and it certainly is prone to affect superficial bones. It is quite intelligible that a trivial bruise, such as would not be noticed during health, might, under such circumstances, be followed by suppuration and sloughing. There is, moreover, very little tendency for this form of necrosis to become diffuse, and the sequestra are usually small.

After typhoid fever it is not at all uncommon, especially on the tibia, and sometimes it is symmetrical; but it may also occur upon the ulna, scapula, parietal bones, or upon the ribs, sometimes ending in necrosis, sometimes clearing up. The jaws are more frequently involved after scarlatina and variola.

Syphilitic Disease of Bone

(1) *In Acquired Syphilis*

In all stages of acquired syphilis, inflammation of bone is exceedingly common. Like the other manifestations, in the early period of the disease it is acute, attended with hyperæmia, but with only a slight amount of exudation; and it begins suddenly, runs a rapid course, and yields readily to treatment. In the later, on the other hand, it is much more chronic, the amount of exudation is larger, and caries and necrosis with suppuration are very prone to occur.

At the beginning of the secondary symptoms, patients often complain of a feeling of soreness in the bones, sometimes amounting to actual pain, keeping them awake at night and flying all over the body, the so-called *osteocopic pains*. The bones are very tender, but there is no swelling and no increased heat over them. Probably, as the parts involved are those in which secondary syphilitic periostitis is especially prone to occur, they are due to a transient hyperæmia of the periosteum scarcely amounting to inflammation.

A little later, after the skin eruption, true periosteal nodes make their appearance. A slightly raised, exceedingly tense swelling forms upon the shaft of one of the long bones (the tibia, ulna, or clavicle particularly) or upon the skull. It is so painful and so tender that the patient will not allow a finger to come near it, and at night cannot bear the contact of the bed-clothes. The skin over it is white and shining, from the way in which it is stretched; the temperature is slightly raised, and the whole bone is more or less tender. The size of the swelling is very small, there is no definite outline to it, it is very low and shades off gradually at the margin. Sometimes it is single; not unfrequently, however, more than one bone is involved, and in the early secondary stage it is very often symmetrical.

The amount of exudation present in these cases and the changes it undergoes depend to a great extent upon the period of the disease. Nodes that are very acute are limited in size and attended with but a slight degree of small-celled infiltration, so that absorption takes place with great rapidity; the periosteum, especially the deeper layer, is thickened, softened, and more vascular; the bone is scarcely affected, or it may be slightly too porous on the surface, and the swelling disappears under treatment without leaving behind any visible alteration of structure.

Those that occur later are more chronic, and affect the bone as well as the periosteum. The pain is not so intense, for the tissues have time to soften and yield ; the amount of exudation is much greater in proportion to the hyperæmia ; the edges of the swelling are more distinct ; and the bone underneath plays a much more important part. Rarefying ostitis sets in ; the cancellous spaces are filled with syphilitic exudation, and even when resolution occurs comparatively early, some permanent alteration is usually left. The hyperæmia disappears of course and much of the exudation is absorbed ; but a considerable proportion usually becomes organised and forms a permanent enlargement with dense osteosclerosis around it and under its base (*an osseous node*). The skull is an exception : pericranial nodes do not ossify ; and if the external table of the bone is absorbed, the defect is not filled up (except with fibrous tissue) and the depression is permanent.

Later still, in the tertiary stage, the amount of gummatous infiltration is very much greater ; and it not only involves the superficial part of the bone, but spreads deeply into its substance, attacking the medulla both in the central canal and in the cancellous spaces. The swelling is much more chronic ; instead of being superficial and limited, it may extend over the whole length and circumference of the bone ; the Haversian canals are enlarged ; the bony trabeculæ and the compact tissue are absorbed ; and the medulla and the deeper layers of the periosteum are converted into a soft, reddish-yellow substance, which readily undergoes caseous degeneration. *Interstitial syphilitic osteomyelitis*, or what has been called diffuse gummatous infiltration, has been added to the periostitis. Sometimes, on the cranium for example, the exudation is greater in one part than in another ; there is immense thickening along one of the sutures or over one of the eminences ; but not unfrequently, especially when one of the long bones is concerned, the whole length is irregularly enlarged, thickened, and tender ; and the soft parts and the skin around and over it are swollen and reddened.

Like gummata elsewhere, these tertiary nodes are much more lasting, and lead to much more serious results than simple periostitis. The exudation may be absorbed almost entirely ; more often, especially at the edges farthest away from the chief focus, it becomes organised, and the bone becomes hard, heavy, and dense ; in most cases, unless it is treated very soon, suppuration sets in ; the skin gives way, the contents of the abscess are discharged, and the surface beneath is left bare and rough, necrosed or carious according to whether it is compact or cancellous. In rarer cases the bone perishes apparently from condensation : the Haversian canals at length becoming so narrow that the compact tissue is cut off from its blood-supply and dies.

On the cranium, syphilitic nodes are exceedingly common. Early ones are soon absorbed ; later ones are more chronic and leave depressions ; tertiary ones that ulcerate and break down lead to the most extensive destruction. The vault is the favourite place ; the whole of the exterior may be covered over with carious ulcers, varied here and there with patches which have undergone necrosis. Sometimes the external table only is diseased, although the internal always shows signs of increased vascularity ; sometimes the whole thickness perishes and more or less circular sequestra are formed. In most the ulceration is annular ; the bone becomes rough and worm-eaten ; a circular groove forms round it, and gradually the granulations grow beneath it and separate it from the rest. More rarely it is pitted ; the compact tissue of the outer table is eaten away in little dots all over ; and sometimes it is tuberculated here and there, nodules of new bone being formed and subsequently in their turn becoming ulcerated and destroyed. Occasionally very extensive absorption of bone takes place without suppuration (fig. 170).

Condensation and sclerosis more often affect the diploe and the inner table, particularly in the frontal region. The bone may become absolutely solid and hard all through, so that there is no trace left of cancellous spaces, and huge masses of dense osseous tissue may be thrown out on the inner surface, between the inner table and the dura mater (subcranial nodes). These are usually symmetrical, arranged on either side of the superior longitudinal sinus (fig. 171). Suppurating gummata in the diploe are more rare; sometimes, however, they cause immense expansion, which chiefly affects the outer table and reduces the intervening tissue to a series of radiating bony bars.

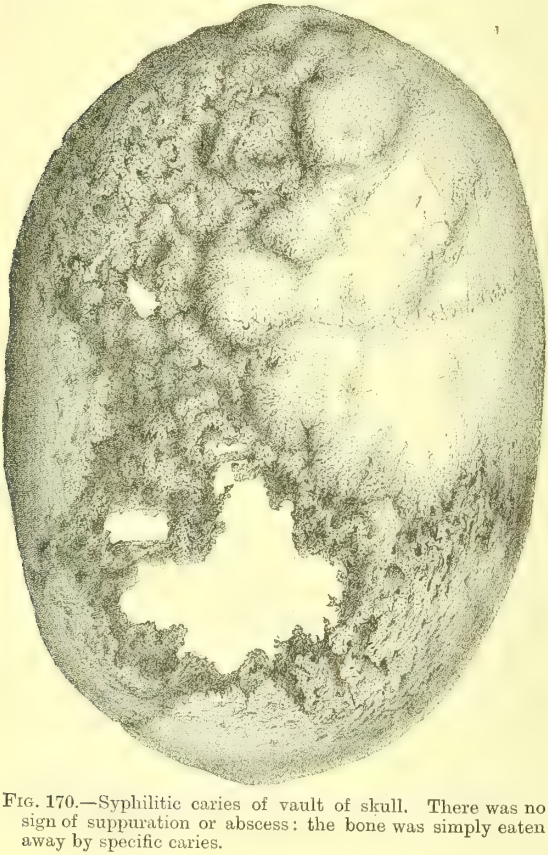


Fig. 170.—Syphilitic caries of vault of skull. There was no sign of suppuration or abscess: the bone was simply eaten away by specific caries.

The long bones are affected in the same way, except that, owing to the osteoplastic function of the periosteum, a greater amount of new tissue is formed upon the surface. The early nodes are acute and soon absorbed; later ones, involving the bones as well as the periosteum, leave a thickening which very often persists. In some cases, in which the deeper-lying osseous tissue and the medulla are especially concerned, the whole bone becomes hard and dense (osteosclerosis); and occasionally the formation of new tissue is so extensive that the Haversian canals become obliterated, and the blood-supply of some of the central portion cut off. If this occurs, and central necrosis is added as a further source of irritation, the whole bone may at length become so changed in shape and density, and so irregular upon the surface, as to lose all resemblance to its former self. This, however, is more common in congenital syphilis, affecting the tibia especially (hyperostosis) than in the acquired form.

In the tertiary stage, when the gummatous material is deposited in larger quantities and has a greater tendency to caseation and suppuration caries and necrosis are more common. Sometimes pus forms between the periosteum and the bone; the former is destroyed by the syphilitic exudation; no new shell is formed upon the outside, the skin gives way, and the bone beneath is exposed, rough and soft upon the surface (caries), so that a probe can be pushed into it. Very often the depression left appears deeper than it really is, because of the deposit of new tissue by the periosteum round the edge. If the bone is deeply involved this may lead to spontaneous fracture. In other cases the exudation is more marked in the central and interstitial medulla; the whole bone is expanded and softened, so that when suppuration occurs and the skin gives way it seems as if it would be entirely destroyed. This is not uncommon in the upper extremity, especially the forearm. That part of the limb is immensely swollen and thickened; the skin is reddened and undermined with sinuses; the shaft of the radius or ulna, as the case might be, is enormously enlarged, so that the size of the swelling appears almost entirely due to the bone; and a probe passed into one of the sinuses can be pushed in almost any direction. The appearance before suppuration sets in is almost identical with that of a rapidly growing sarcoma; but even in advanced cases resolution and absorption take place readily under the influence of iodide of potash combined with tonics and good food. The same thing is not uncommon in connection with the phalanges of the fingers and toes, both in the hereditary and acquired form, leading to a very great enlargement, of a peculiarly uniform shape. Occasionally it ends in necrosis.

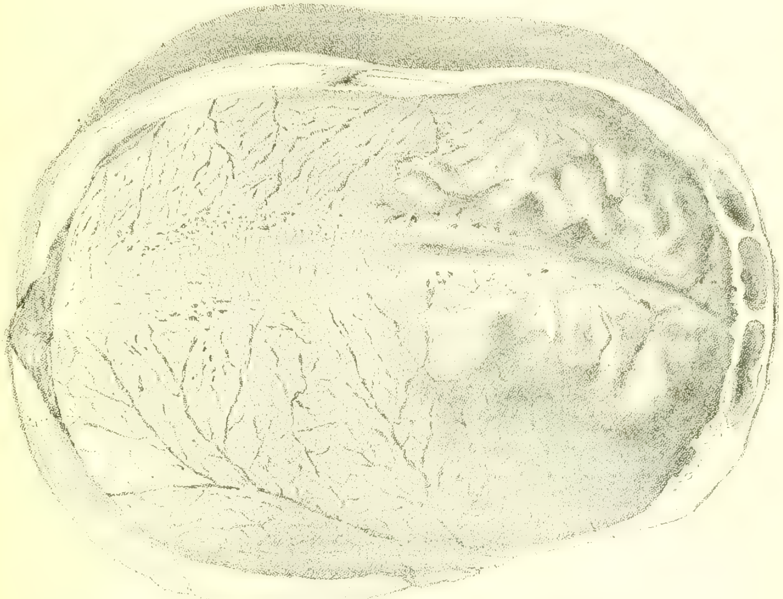


FIG. 171.—Symmetrical nodes on inner surface of frontal bone. The diploe is filled in, and the grooves for the meningeal arteries are much too deep and too numerous.

The other bones are not exempt. The cervical vertebræ may be affected and cause disease of the occipito-atloid, or atlo-axoid articulation. Gummatous deposit may occur beneath the mucous membrane of the nose and lead to necrosis of the nasal bones. Perforation of the hard palate (always exactly in the middle line) and destruction of the nasal septum and of the turbinate bones are not uncommon. The jaws may be affected, the upper more often than the lower, causing large portions of the alveolar margin to undergo necrosis, and leading to loss of teeth; and this may occur in patients who have never taken mercury. In short, nearly every bone in the body may be affected to a greater or less extent, the changes being practically identical in them all, depending upon the amount of the syphilitic exudation, the length of time it is allowed to destroy the bone, and the subsequent changes it undergoes.

(2) *In Congenital Syphilis*

Bone-lesions are very common in congenital syphilis, occurring *in utero*, during the first few months of infancy, and later at puberty, in the same way as the other manifestations. Those that appear in early infancy, and some of the later ones, are peculiar to the congenital form and are never met with in the acquired; but gummata, followed by caries and necrosis, occur as well, and cannot be distinguished from ordinary tertiary ones, except perhaps that they are more intractable and yield less readily to iodide of potash.

(*a*) The early changes are partly inflammatory, attended with new growth and the formation of fresh bone, partly atrophic, with wasting and degeneration. Not unfrequently, as in some other constitutional affections of bone, the two are found together side by side. As a rule they appear within the first year, often within the first three months.

1. The former chiefly occur under the pericranium and under the periosteum of the shafts of the long bones. On the skull they are known as *Parrot's nodes*, and are of themselves absolutely characteristic. They form four broad flattened bosses, sometimes half an inch in thickness, surrounding the anterior fontanelle, one on each parietal bone, one on each half of the frontal. Between them is a deep crucial depression, corresponding to the sutures, and a skull marked in this way is described as 'natiform.' The centres of ossification are not involved; the new bone originates in the deeper layers of the periosteum, and very often spreads down the sutures until it meets across and bridges them. At first it is very vascular and porous, consisting of more or less perfectly developed horizontal lamellæ, united by trabeculæ

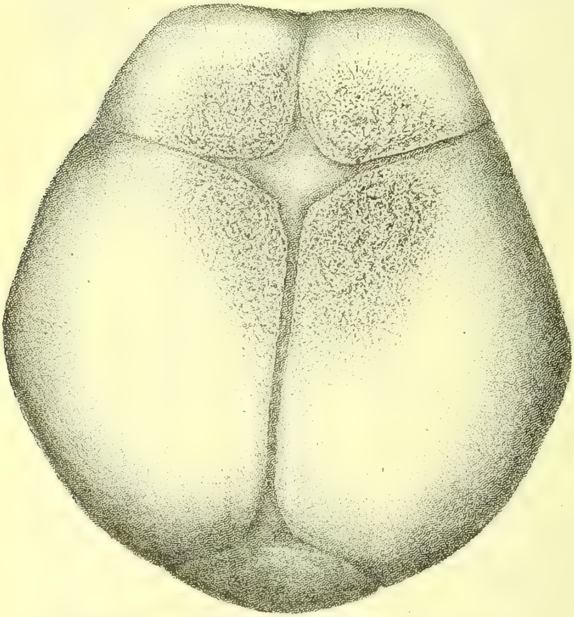


FIG. 172.—Parrot's nodes round the anterior fontanelle.

running in a vertical direction ; in the interspaces is a soft pulpy medullary substance, continuous through the widely dilated Haversian canals with that in the bone underneath. At a later period it becomes more dense and solid.

The shafts of the long bones, especially near the epiphyses, are not unfrequently sheathed in with a similar deposit arranged in layers around them, sometimes quite soft, and hardly ossified at all (the periosteum then separates more easily than natural), sometimes hard and dense. It may be associated with changes at the growing ends of the bones, but not necessarily so in any way. In some of these cases the medulla is found to be replaced and the central canal filled with a fine trabeculated soft spongy mass.

2. The atrophic changes (*gelatiniform degeneration*) are also met with on the skull under the pericranium (by which they can be distinguished from craniotabes, which is simply a wasting of the bone under certain conditions from long-continued pressure) but the situation is not a common one. The favourite place is at the ends of the long bones, especially of the elbow-joint. though none are exempt. Strictly speaking the epiphysis is not affected, the disease attacks the growing layer at the end of the shaft and the cartilage (intermediary) that immediately joins it. The medullary spaces in the growing bone increase enormously in size ; the new-formed vertical lamellæ waste away, the medulla itself becomes converted into a peculiar gelatinous mass ('like fluid jelly,' whence the name given it by Parrot), from which the cells disappear, leaving little but a fibrillar network with blood-vessels running here and there. In some cases there is a layer of this soft semi-diffluent material, a line in thickness, between the cartilage and the bone. The cartilage itself undergoes a different transformation ; the matrix becomes calcified to an abnormal extent, the cells are prematurely enclosed, and the brittle vertical lamellæ rest upon the soft gelatinous layer on the end of the shaft.

In many respects these changes closely resemble those that occur in rickets, and the difficulty of distinguishing them is rendered greater by the fact that the two diseases not unfrequently coexist. Parrot's nodes, however, are distinctive.

The symptoms to which these changes give rise are very characteristic. A soft, puffy, tender swelling forms round the end of the bone, involving the joint ; the limb is perfectly helpless (it has been called *syphilitic pseudo-paralysis of infants*), it bends and yields with the least pressure, and sometimes a certain amount of soft grating can be felt as if there was a separation between the calcified cartilage and the soft tissue at the end of the shaft. In the worst cases this does actually take place, and the end of the bone can be felt free and detached. Later, owing to the way in which the limb is constantly being hurt as soon as the strength of the central support is lost, suppuration may set in, generally under the periosteum at the end, rarely between the bone and the epiphysis. Resolution under appropriate mercurial treatment is the rule, but not unfrequently premature ossification follows, and the growth and development of the body are arrested ; not only does the size remain small, but the changes that normally occur at puberty are delayed. In the worst necrosis may follow, but such cases rarely survive sufficiently long.

(*b*) In the period between infancy and early puberty the bones, like the other tissues, are rarely affected. Gummata may occur, but they are not usual. At puberty there is a fresh outbreak.

The form this takes is in many instances as characteristic as the one already described. The shafts of the long bones, especially the tibia, are the parts most commonly attacked. Ill-defined periosteal nodes, not so acute as those met with in secondary syphilis, make their appearance on the skin; at first they yield to treatment fairly well, though a certain amount of thickening is always left; but they return again and again with the greatest obstinacy, and each time they resist absorption more and more. At first the periosteum only is affected, the superficial lamellæ are a little more vascular, but that is all; in a short time, however, the inflammation shows itself in the bone, and before long the whole of the shaft becomes thickened, bent (usually in exaggeration of the normal curve), lengthened perhaps, and covered over with great irregular bosses. On section the normal compact tissue can hardly be distinguished; the whole of the bone is dense and hard, immensely thickened and altogether altered in shape (*hyperostosis or interstitial condensing ostitis*).

Sometimes, when, I believe, it occurs at an early age, this is symmetrical, though usually one leg is much worse than the other; if it breaks out for the first time later in life (and it may not appear until two or three and twenty) this is not the case. In most instances the tibiæ are affected, but the bones of the upper extremity, especially at the elbow, not unfrequently suffer as well, and sometimes the clavicles, ribs, scapulæ, and other bones are attacked too. Generally it is limited to the shaft, but it may extend to the epiphyses, especially the upper one on the tibia, and then it is always accompanied by synovitis, with effusion into the joint and thickening of the synovial membrane. In the milder cases suppuration does not occur; in the more severe ones, after the disease has lasted some little time, the syphilitic deposit under the periosteum perishes, and the bone is exposed at the bottom of an ulcer, bare, hard, and rough. The sequestra are usually superficial, but owing to the dense character of the bone beneath they often do not separate for years; and by the irritation they cause, and the assistance they get from pyogenic organisms, they lead at length to such an amount of solid œdema, ulceration, and sclerosis, that the limb resembles an old gnarled tree-trunk more than anything else.

Besides these, many other lesions are met with in congenital syphilis similar to those of the acquired form. Necrosis of the nasal bones and of the ethmoid is not uncommon, leading to great deformity and attended with a profuse and intensely offensive discharge from the nose; the whole of the frontal bone is sometimes exposed, bare, rough, and almost black; perforation of the hard palate in the middle line is often met with; inflammation of the phalanges of the fingers occurs occasionally; and in short there is scarcely a part of the body in which the bones may not become the seat of gummatous deposit and perish, either in minute fragments (caries), or in large ones (necrosis).

Symptoms.—Pain, heat, swelling, and redness are present as in other forms of inflammation, varying very greatly in intensity. The first is the most constant. In acute cases it is very severe, and like all bone-pain is much worse at night and after exertion; the skin over the affected part is exquisitely tender, the patient will not allow a finger to come near it, and the whole bone when it is percussed is highly sensitive. When the inflammation is more chronic this is much less marked, but a dull aching sensation, becoming more severe under the same conditions, is rarely altogether absent.

The amount of heat and redness depends chiefly upon the locality of the inflammation, whether it is near the surface or not, and upon the presence of suppuration. Like the other signs, they are much more severe when the attack is acute. The swelling is of great importance, as the diagnosis of the cause depends very largely upon the locality and the part of the bone involved. In the secondary stage the shafts of the long bones and the skull are affected, and the swelling is tense, circular, and very small, limited to one surface of the bone, chiefly periosteal. In the tertiary it is much larger and more chronic: the whole bone is involved; the swelling is uniform in shape, extending around, as well as along the shaft; and the same is true of the hereditary form when the long bones are attacked.

In children syphilitic nodes are very difficult to distinguish from the strumous or tubercular, especially when the metacarpal bones and the phalanges are concerned; the swelling is the same in shape, the other symptoms are the same, and often it is necessary to rely upon the other signs that are present. In adults, or when the long bones of the limbs are concerned (*e.g.* the radius or ulna), there is not the same difficulty, as tubercle under these conditions is rarely met with, and does not, like tertiary syphilis, attack the compact tissue of the shaft.

As the inflammation extends, other signs make their appearance: suppuration may occur with caries or necrosis; an osseous node or enlargement of the whole bone may be left from organisation of the exudation; neighbouring structures may become involved, the joints for example may become inflamed, the cortex of the brain may be irritated or compressed, nerves and blood-vessels may be pressed upon; and in some cases the destruction is so great as to cause the most serious deformity.

Diagnosis.—Strumous nodes, as already mentioned, closely resemble hose that occur in tertiary and hereditary syphilis, especially when the bones of the hand or foot are attacked. In each there is a chronic enlargement of he whole bone, with a tendency to break down and caseate, and in many nstances it is only possible to distinguish one from the other by the history or the presence of other signs. Ulceration of the scalp with caries of the ubjacent bone in children is generally tubercular, after puberty it is more often syphilitic, especially if it is attended with necrosis. In the case of the ong bones tubercle nearly always begins in the cancellous ends, which rarely uffer in the course of syphilis.

Rheumatic nodes, leading to chronic ostitis, are still more difficult to disinguish. The symptoms in each are due to the condensation and sclerosis, nd practically present no difference. Osteocopic wandering pains may occur n rheumatism as well as in syphilis.

Tertiary syphilitic nodes can in some cases only be distinguished from arcomata of bone by a course of iodide of potash; and, as rapidly growing umours are always accompanied by a certain amount of inflammation periostitis and ostitis), a definite conclusion must not be drawn until there is very distinct degree of improvement. In doubtful cases it may be necessary o make an exploration with a trocar and cannula.

From rickets the difficulty of distinguishing hereditary syphilis is greater till. Craniotabes, enlargement of the epiphysial ends with thickening and owing of the shafts, and bending of the ribs are present in both; but as a ule in syphilis the course is more acute and the disease not so uniformly istributed over the body; the stress of the complaint seems to fall on one or two parts. Separation of epiphyses and Parrot's nodes may be regarded as distinctive. In the latter stage the enlargement of the tibiæ that is so common in hereditary syphilis has often been confounded with the bending and the concavity that occur in rickets, but the enormous overgrowth in all directions, not in one only, and the irregularity of the surface, are never met with in the latter.

Treatment.—The treatment proper to the stage of the constitutional disease must be thoroughly carried out. Secondary syphilitic nodes yield at once to small doses of iodide of potash, but relapses are very common. Tertiary ones are less satisfactory; it is often necessary to increase the amount very largely before any effect is produced, and even then in some instances it is of very little avail by itself. Rest, warmth, tonics, good food and fresh air are no less essential, especially in inveterate cases, and not unfrequently when iodide of potash appears to fail altogether, it succeeds at once if the patient is sent to the seaside and made to lay up completely. The hereditary nodes that occur at puberty are still more intractable. The bone becomes sclerosed and dense, and nothing seems to have any effect upon it. In some of these cases, in which it is evident that the pain is kept up rather by the local condition than by the constitutional taint, linear osteotomy may be performed with advantage.

The inflammation that occurs in infancy must be treated with mercury in the same way as other infantile manifestations. The prognosis, if only one joint is affected, is good; if, however, there are several, or if suppuration occurs, recovery is very doubtful; rickets and visceral lesions are nearly always present as well, and even when the specific symptoms abate, the child generally dies from wasting and exhaustion, or from some comparatively trivial intercurrent disorder.

RHEUMATIC OSTITIS

In chronic rheumatoid arthritis the bones become inflamed, as part of the joints, together with the other tissues. Atrophy and absorption take place to a certain extent along the line of pressure; and around the margin osteophytes are thrown out, dense hard masses of new bone, sometimes formed under the periosteum, sometimes due to the ossification of ecchondroses.

In addition to this the bones themselves are liable to a form of ostitis, which, like rheumatic inflammation generally, tends to organisation and sclerosis. Suppuration never occurs. The periosteal surface is roughened and irregular with outgrowths; the compact tissue beneath is exceedingly dense and hard; and the medullary canal is contracted. The changes, in other words, are typically those of osteosclerosis, exceedingly chronic, progressive, and attended with a considerable degree of aching pain which is worse at night and when exposed to damp.

Very little can be done for this condition; iodide of potash has scarcely any effect upon it, although it relieves the pain to a certain extent. Strong iodine liniment painted over the part, mercurial ointment well rubbed in, flying blisters and other forms of counter-irritation are often serviceable in the same way; the progress of the inflammation is stayed and there is only the inconvenience arising from the increased size and weight of the bone. If this does not succeed, and the pain is severe, trephining, or linear osteotomy, according to the part of the bone involved, should be tried. Very often this gives perfect relief, apparently by diminishing the tension of the part, or by the subsequent changes that take place in the bone.

Tubercular Ostitis

This may occur either as part of a general disorder (acute miliary tuberculosis), or as an affection that is at first local and invades the surrounding tissues slowly, although under certain conditions it may become the source of a general infection. The former has practically no surgical importance and does not admit of recognition during life; the latter is the same as what has hitherto been known as scrofulous disease of bone.

The cancellous tissue is the part chiefly affected, the ends of the long bones, the bodies of the vertebræ, and the carpus and tarsus; but it may occur upon the skull, and in children it often attacks the phalanges and the metacarpal bones. The shafts of the long bones of the limbs, the favourite seat of syphilitic disease, are practically exempt.

It begins, like chronic inflammation of cancellous tissue generally, as rarefying ostitis. The trabeculæ are softened and thinned at one spot; the medulla is replaced by reddish granulation-tissue, round the margins of which typical miliary tubercles may be found; and this in its turn is enclosed by a ring of hyperæmia. Occasionally there are several of these close together, gradually enlarging until they coalesce.

The subsequent changes depend upon the activity of the bacillus and the power of resistance possessed by the tissues.

In some cases *caries sicca* sets in; the granulations continue to grow and increase without caseating or suppurating, and gradually the whole bone is absorbed and replaced by a soft vascular mass, more or less representing it in shape, according to the amount of pressure it has to sustain. After a time this may break down and caseate, or it may slowly disappear, leaving a hard, shapeless, irregular mass of dense fibrous tissue and bone.

More often the granulation-tissue in the centre becomes soft and yellow; caseation, followed by liquefaction, sets in; and a tubercular abscess (so called) is formed. Sometimes even then, if the nutrition of the part improves, sclerosis may take place around and enclose it: much more frequently the neighbouring cancellous spaces become involved; the trabeculæ perish and fall off in fragments of various sizes (if they are of any dimensions it is known as *caries necrotica*), and a cavity is formed filled with a caseous liquid mixed with débris and minute sequestra, and enclosed by walls of soft carious bone, in the medullary spaces of which miliary tubercles may be found here and there. So long as these continue to form the softening spreads, until at length at some point it reaches the limit of the bone. If this is under the periosteum further progress is often barred by thickening and condensation and the formation of new layers, so that the evacuation of the contents is checked. If it is near the articular surface, unfortunately this cannot take place; as the infection spreads the cartilage gradually becomes undermined, until it is detached or perforated by the granulations, and the tubercular material spreads at once over the synovial cavity.

When the compact tissue of the skull or of the other flat bones is involved the changes are essentially the same, only, as might be expected from the structure of the part, necrosis is a more prominent feature. Sometimes wedge-shaped sequestra are found in the articular ends of the long bones, and it has been suggested that these are really due to embolism, the bacilli having been suddenly distributed over all the vessels of the affected region, and from their number setting up such an acute attack of inflammation as to cause necrosis. In the phalanges and metacarpal bones (rarely in the other long bones, even in children) the disease sometimes takes the form of expansion, giving rise to an enlargement apparently similar to that met with in syphilis but without any sclerosis; there is a deposit of tubercle in the centre of the bone, spreading into the interstitial medulla of the shaft, and, as the interior becomes hollowed out, layer after layer of vascular new tissue is formed under the periosteum, until at length the size of the part is more than doubled (*spina ventosa*) (fig. 173).

Symptoms.—In tubercular ostitis these at the first are very vague and indefinite. If the bone is deeply seated, as for example the body of a vertebra, pain (often referred to the distal end of the spinal nerves), a little tenderness on pressure, and a peculiar rigidity of the muscles around the part, are the only signs, until the loss of tissue causes deformity. When it is superficial the diagnosis is more easy: there is an ill-defined enlargement, due at first to thickening of the soft tissues and the periosteum, later to expansion of the bone itself: but there is very little pain, even at night; tenderness on pressure is very slightly marked, and unless the skin is involved there is no rise of temperature perceptible to the hand, and no redness or pitting.

Later, as the inflammation extends to the neighbouring structures and the area of softening enlarges, it becomes more easy. Neighbouring joints become involved: at first there is simply an increase in the synovial effusion, due to the presence of a focus of inflammation near, but later, when the cartilage is perforated by the granulations, tubercular infection takes place, and thickening and pulpy degeneration follow. Characteristic deformity, shortening of the phalanges for example, or angular curvature of the spine makes its appearance; and when the abscesses break or are opened, sinuses are left lined with tubercular granulations and leading down to soft carious bone, into which the blunt end of a probe sinks with ease.

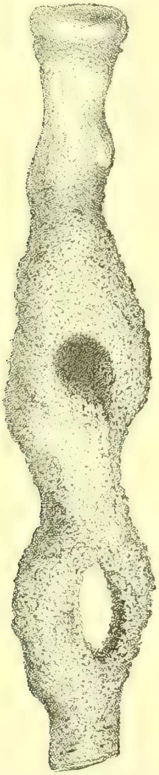


FIG. 173.—Radius from a case of tubercular caries, showing what has been called inflammatory expansion of bone, or spina ventosa.

Diagnosis.—Tubercular ostitis is met with in adults, and exceptionally in old age; but it is by far the most common in childhood and young adult life. In a very large proportion of cases there is evidence either of the presence of tubercle elsewhere, or of a distinct constitutional predisposition; and not unfrequently the personal appearance is characteristic. So far as the local symptoms are concerned the diagnosis rests chiefly upon the part of the bone involved and the peculiarly chronic and insidious character of the inflammation. The difficulty is greatest in the strumous dactylitis of children, which is very closely imitated by the syphilitic form. In the later stages the uniform character of the swelling, the whiteness of the skin, except at the actual point of suppuration, the soft doughy sensation when it is pressed upon, the presence of caries, and the thin oily character of the liquid discharged are distinctive.

The prognosis depends partly upon the constitutional predisposition of the patient, whether the taint is very strongly marked, partly upon the seat and intensity of the inflammation. Where, for example, there is a possibility of complete local removal before the surrounding structures are involved, or where caseation and liquefaction are delayed, and the granulation-tissue tends rather to organisation, there is much better hope than when the bodies of the vertebræ are concerned and when the bone breaks down at once. Even then, however, although the destruction may be very extensive, the whole of the tuberculous mass may at length dry up and calcify or come away; and as the patient's health improves, the process of softening and decay may come to an end, and give way to sclerosis and organisation. Bony ankylosis, for example, may occur in the spine even after the bodies of several of the vertebræ have been destroyed.

In a very large proportion of cases the period of quiescence and organisation unfortunately is only temporary. For the moment, under the influence of treatment, or owing to the patient's vigour of resistance, the spread of the tubercle is arrested and active repair sets in; but unhappily there is always the danger that, from slight local injury or from general failure of health, the disease will become active again and the inflammation commence afresh.

Treatment.—The constitutional treatment is the same as that required in other cases of tuberculosis. Local measures must be guided by the situation and the character of the inflammation. Rest is absolutely essential. The amount of blood flowing through the part should be perfectly uniform; venous congestion and transient hyperæmia are equally injurious. Cold is of great service, not only in checking the inflammation, but in arresting the growth of the bacillus; care, however, must be taken not to lower the vitality of the tissues too much. In very chronic cases counter-irritants may be used, iodine, blisters, and even the actual cautery, but not on the distal side of the disease or immediately over it, if it is superficial, for fear of lighting up fresh mischief.

If, however, the disease is more active from the first, or if from its situation there is reason to fear its extension to a joint or to some other important structure, it should, if accessible, be thoroughly removed, every precaution being taken to prevent its becoming more widely disseminated by the operation. The limb should be raised; Esmarch's bandage applied to control, not only hæmorrhage, but absorption through the veins; the cavity freely opened (as far as possible with cutting instruments, so as to avoid crushing or bruising) and thoroughly evacuated. The granulations lining it and the soft carious bone around it should then be freely cut away, and the wound plugged with iodoform gauze, or washed out with an ethereal solution of iodoform. Afterwards it must be kept as dry as possible by a proper system of drainage, and every precaution taken to prevent decomposition and suppuration. Carious bones in which sinuses are already present may be treated in the same way if they show no inclination to get well with milder measures. The os calcis, for example, may be entirely scooped out, merely leaving a periosteal shell, with an excellent result.

RICKETS

Rickets is a constitutional disorder occurring in early life and characterised by a peculiar condition of the bones affecting especially their epiphysial ends. Other lesions are met with in the viscera in fatal cases, but this is the only one that is universal and distinctive.

Pathological appearances.—The changes are most marked in the growing portion of the bones; the older parts, those that are already firm and well ossified, are but little affected in comparison, although there is in them a diminution of the earthy salts with enlargement of the medullary spaces and Haversian canals.

The periosteum everywhere is thickened, softened, and too vascular; it strips away too easily from the bone beneath; the line of separation between the deeper layer (the osteoid tissue) and the surface of the shaft is ill defined, and the exterior of the latter is covered with laminæ of soft porous bone. In between these, separating them from each other, is a kind of fibrillated medullary substance: some of the cavities perhaps are formed afresh, but others are due to absorption of the part already developed and the enlargement of the interstitial medullary spaces near the surface. In other words, the circumference of the bone continues to enlarge; the quantity of soft organic material increases (actually, probably, as well as relatively); the amount of bone developed is very much less; and what there is is deficient in lime salts.

Changes of a similar character take place at the epiphysial ends. Normally, between the cartilage and bone, there is a narrow, greyish, semi-translucent line, visible to the naked eye, of cartilage that has undergone the transformation preliminary to the development of bone. In rickets this layer is many times too thick; and instead of being sharply and clearly defined from the bone already formed, there are most irregular prolongations of it, penetrating deeply here and there between the growing lamellæ beneath (fig. 174). The microscopic anatomy shows a similar change. The cartilage cells multiply to an altogether unusual extent; the primary capsules are much larger than normal; and the calcification of the matrix is excessive. Meanwhile, the soft medullary tissue in the growing bone beneath, increases greatly in amount, and becomes finely fibrillated. The altered cartilage is invaded and absorbed; but instead of the spaces so formed being lined with laminæ of new bone, until the central hollow is narrowed down to a Haversian canal, that which has been already deposited is removed, and the trabeculæ are weakened to such an extent that the line of junction becomes soft and yielding.

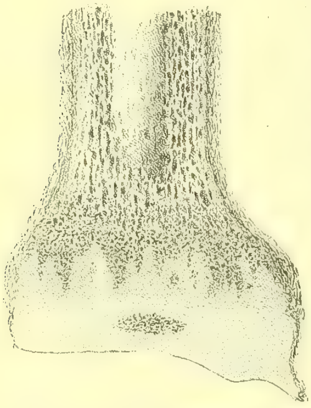


FIG. 174.—Section through lower end of bone affected with rickets, showing the enormous thickness of the gelatinous layer and the extreme irregularity of the line of ossification.

The effect produced by these changes is easily imagined: the soft tissue at the epiphysial ends of the long bones yields before the pressure it has to sustain, and bulges out at the sides, forming the peculiar tender and characteristic enlargement; the shafts of the bones, the strength of which is impaired by the advancing absorption, give way and bend at their weakest part; the curves that are normally present become exaggerated; and in some cases they are so strongly marked that, when the bones are subcutaneous, like the clavicle, it may be difficult to distinguish them from greenstick fractures, especially as the tenderness on pressure is not unfrequently quite as great.

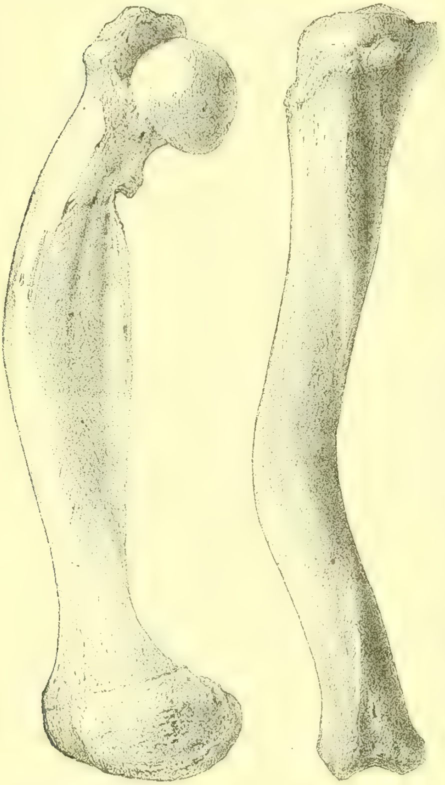
As soon as the morbid process comes to an end and health is regained, ossification sets in and proceeds at an unusually rapid rate. The compact tissue of the shaft becomes peculiarly dense and hard; the growing layer at the end, where it abuts upon the epiphysis, is converted into bone, so that development is stopped too soon; and the osteoid tissue under the periosteum undergoes the same change so far as the concavity of the curve is concerned. On the convexity it is absorbed and disappears, and the compact layer of the shaft is left thinner than normal. This change is produced gradually, and, like the similar ones that occur in connection with badly united fractures, is the result, not of the rickets, but of the alteration in the shape of the bones. The concavity is strengthened because it has to sustain the weight of the part and has more than its normal share of work; the convexity becomes thinner for the opposite reason.

The extent to which the various bones are affected depends upon the age and habits of the child, whether it is unable to stand or whether it has commenced to walk. Every part of the body may be more or less distorted.

The cranium becomes peculiarly square and flat on the top; ossification is delayed along the sutures; the anterior fontanelle, instead of closing at the twentieth month, remains open until the third or fourth year; and, owing to their being unable to resist the internal pressure, the bones separate to a certain extent from each other. This is usually associated with some degree of chronic hydrocephalus. If the child lies upon its back (and very often the same position is retained for hours together, owing to the pain caused by muscular exertion) the occipital bone becomes flattened and in places absorbed (*craniotabes*). The constant pressure of the brain causes such wasting that opposite the convolutions the bone completely disappears: the dura mater comes into contact with the pericranium; the wall of the skull becomes as thin as parchment; and, especially at the sides of the occipital bone, where ossification is normally later than elsewhere, firm pressure with the finger makes it crackle and bend in. The growth of the face is checked: in many instances this is more apparent than real, owing to the way in which it is overhung by the forehead; but later in life, at puberty, the arrest of development cannot be mistaken. The temporary teeth are always cut very late; and when at last they do appear, they break off and decay in a very short time. In certain rare cases the bones of the skull, in particular those developed in membrane, become enormously thickened, soft, and porous; the orbits are partially blocked and the optic nerves atrophy; but this, though common in animals, is very unusual in man, and is so different that by many it is not considered due to rickets.

If the child is old enough to sit up the vertebral column becomes distorted and bent. The head is usually thrown back, so that the spines of the cervical vertebræ are deeply sunken, and the whole of the dorso-lumbar region forms one great curve with its convexity backwards. As a rule, this extends from the lower cervical region to the sacrum, and is perfectly uniform, so that there is no fear of mistaking it for the angular curvature of caries. Sometimes, however, it is very sharply marked, especially in the lower dorsal region, and the resemblance then is exceedingly close, especially as, at the same time, the muscles are rigidly contracted, owing to the pain that movement causes. In other instances, when the disease first begins at a later period, the natural curves may be simply exaggerated; or lateral curvature with rotation of the bodies may come on and end in the most extreme distortion.

The deformity the thorax undergoes (*pigeon breast*) is characteristic. The sternum is thrust forwards by the ribs, partly from the increased curvature of the spine, partly from the yielding and sinking in of the walls of the thorax at the costochondral line. The chest is flattened at the sides (less so on the right, owing to the liver, than on the left); there is an abrupt bending inwards of the ribs near their junction with the cartilages, leading to the formation of a groove on the antero-lateral wall of the chest, from the third rib downwards and slightly outwards; and at the lower border of the sternum this becomes continuous with a nearly horizontal constriction corresponding to the attachment of the diaphragm. In addition, the costochondral line is marked by a series of enlargements (the so-called beading of the ribs) analogous to the thickening and softening of the epiphyses on the ends of the long bones. Very often these nodes are so distinct upon the inner surface as to form distinct impressions upon the lungs and even upon the liver.



FIGS. 175 and 176.—Femur and tibia deformed by rickets. The bones are exceedingly short (premature ossification of the epiphyses), the natural curves are much exaggerated, and the concavities are buttressed up with masses of dense compact bone, arranged along the lines of pressure. This is best seen in the tibia, for the linea aspera is to a certain extent normal.

The brim of the pelvis is widened and flattened by the pressure of the abdominal organs from above; but the cavity is very much contracted, and at puberty is unable to assume its characteristic development. The antero-posterior diameter is lessened by the projection of the sacro-vertebral angle, and the acetabula and the ischial tuberosities are pushed in from the sides, until it is forced into a trefoil shape. Occasionally laminæ of new, soft, porous bone are formed upon the surface similar to those under the periosteum of the scapulæ and the long bones.

Of all the long bones, the tibiæ are the ones that suffer most conspicuously. The curve is generally most marked at the junction of the middle and lower third; sometimes it is very sharp and strictly antero-posterior, the bone being flattened from side to side until it is scarcely so wide across as the fibula; in other cases, it is bent inwards or outwards as well, and overhangs the foot, the difference depending, in all probability, upon the age of the child, whether it is old enough to walk about of itself or is carried constantly upon its back (figs. 175 and 176). The femur is always bent forwards; the head is usually sunken, so that it is much below the level of the trochanter, and the linea aspera is exaggerated into a great buttress of bone towards which all the pressure lines converge. In the upper extremity, the amount of distortion is rarely so great; but the clavicles are sometimes very sharply bent, and the humerus and radius may be considerably bowed, especially when the child is in the habit of propping itself up upon its hands. In other cases, there is little deformity of the shaft, owing to the fact that it carries no weight; but the lower epiphysis of the radius, no matter how slight the attack, rarely fails to show a certain degree of thickening.

The other pathological changes met with in rickets are less constant, but they are much more frequently the cause of death. Bronchitis and broncho-pneumonia with collapse of the lung are rarely altogether absent in fatal cases. There is usually evidence of gastro-intestinal catarrh, and the solitary glands and Peyer's patches are often unduly conspicuous. The liver is enlarged and very frequently fatty, often showing the marks caused by the ribs. The spleen is generally increased in size and is tougher and more dense than natural. The muscular system is ill developed; the ligaments, especially in the later stages, are lax and yielding, so that not unfrequently they become much too long; and, in short, there is evidence of general malnutrition affecting the whole body, though it only produces characteristic changes in the bones.

Causes.—Rickets may be caused by anything that impairs nutrition; it is possible that an excess of starchy food at a period of life when it cannot be assimilated is one of the most potent factors; but it is certainly not the only cause, and in no sense is it to be regarded as a specific one.

Weakly parents, in whatever station of life they may be, and whatever the cause, produce feeble children; and these, as they are almost always exposed to the same injurious conditions, become rickety. Distinct evidence of rickets (not fœtal rickets, which is probably entirely different) has been found in the fœtus and is not uncommon within a few weeks of birth, at a time when the ordinarily assigned causes, improper food, want of air and light, &c., can hardly have produced any effect. In the lower classes, frequent pregnancies and prolonged lactation, combined with the greater difficulty of obtaining proper food for a larger number, often reduce the health of the mother, so that the later children show definite evidence of rickets, while the earlier ones escape.

Artificial feeding, unless it is carried out with the greatest care and with especial regard to a child's requirements, will always cause it; and for this reason, among others, it is met with in all classes of life. It may, however, occur in infants at the breast when the milk is insufficient in quantity or quality; and it is practically certain if the child is suckled for too long a time.

Bad ventilation, want of fresh air and sunlight, overcrowded rooms, and neglect of ordinary hygienic conditions, greatly favour its occurrence, not only by the direct effect upon the child, but by the way in which the health and strength of the patient become deteriorated. For this reason, it is much more common in towns where there is overcrowding than in the country. Syphilis, tubercle, and other disorders are very commonly associated with it; and they must be regarded as predisposing causes from the influence they have upon the health of the parent as well as upon that of the child. Rickets is not, however, in any sense of the term, directly produced by them.

Symptoms.—Rickets may be present before birth; craniotabes (occurring then on the inner side of the vertex of the skull owing to the position of the fœtus) and acute bending of the bones (infractions) have been found on many occasions; within the first few months of life beading of the ribs is quite common; after two years old it is rare for the disease to begin, though exceptional cases have been met with as late as eight or ten. Sometimes, but by no means always, the children are miserable, wasted, and puny; in many instances there is nothing remarkable about their appearance; and occasionally it occurs in those that are apparently well fed, with plump, rounded limbs, of unusual size and weight for their age.

Sometimes it commences acutely; suddenly, almost from one day to another, the bones become tender, the contraction of the muscles exceedingly painful, and the child lies perfectly still on its back, afraid to move on account of the pain, and crying as soon as anyone comes near. Occasionally the inability is so marked that such cases have been mistaken for general infantile paralysis. Much more commonly the onset is so insidious that it is impossible to assign even an approximate time. Profuse perspiration about the head, and throwing off the bed-clothes persistently at night; a rather large, square-shaped head; delay in dentition or in closure of the anterior fontanelle; a prominent abdomen, with occasionally diarrhœa and very offensive motions, are all present in the early stages of rickets, and should always, especially when they occur together, excite grave suspicion; but they are not uncommon in perfectly healthy, well-fed children, who neither then nor afterwards show any sign of the affection.

Enlargement of the epiphyses, especially of the wrist and ankle, beading of the ribs, and craniotabes may be regarded as definite signs. The child, to use the popular expression, is taken off its legs; it loses its liveliness, becomes peevish and fretful, and is only too happy if it is left alone; movement is attended with pain, the muscles become soft and flabby, the ligaments loose and yielding (double-jointed), and if the back is involved even the power of sitting up may be lost. Bending of the bones and deformity then begin to make their appearance; owing to the respiratory movements the thorax always suffers and becomes pigeon-breasted; and later, according to the age and habits of the child, the long bones of the limbs become affected.

Bronchitis, with collapse of the lung and broncho-pneumonia, is of common occurrence and may prove fatal; gastro-intestinal catarrh and diarrhœa are very often present, not unfrequently assisting as a cause; and according to Parker, no less than two-thirds of all the convulsive attacks to which children are liable (laryngismus stridulus, carpopedal contractions, tetany, strabismus, &c.) are due to or associated with rickets. Flat-foot, knock-knee, and lateral curvature of the spine, all of which are the outcome of weakness of the muscles and ligaments, usually, when the result of rickets make their appearance at a later date.

Prognosis.—Except in acute rickets, which is not unfrequently fatal, the prognosis is, generally speaking, good. Bronchitis, convulsions, and diarrhœa must, however, always be regarded as very serious. In the vast majority of cases, although the growth of the bones is very liable to be checked, the deformity practically disappears, except so far as the thorax and skull are concerned; the pigeon-chest and the peculiar square-shaped cranium, if once thoroughly developed, persist through life. Probably the same is true, though perhaps not to the same extent, of the pelvis. In a few cases the bones never regain their normal outline; the neck of the femur is horizontal, and the shaft and that of the tibia are bowed; and in these the diminution of height, from premature ossification of the growing line, is always very distinct.

Treatment.—In most little more is required than careful attention to diet and the general principles of hygiene. In this respect the mother's health is of scarcely less importance than the child's. Cod-liver oil acts as a specific, and there are very few children, especially rickety ones, who cannot be induced to take it, or who do not even become fond of it. It should be given after food, and in small doses several times a day; large ones are more liable to create repugnance and may disagree. Iron is especially indicated where there is much anæmia. Lime, in the form of lime-water, is a necessary addition to the milk of most large towns, but by itself it has no power over rickets. The lacto-phosphate of iron and such preparations as Parrish's food are more valuable.

The diet must be as nutritious as possible, but at the same time well diluted, or it may create indigestion and do more harm than good. For young infants, cow's milk diluted according to the age, with milk sugar, and perhaps a few drops of some pancreatic preparation added, is most suitable. For older ones, some of the artificial foods, the yolk of an egg, or, if the symptoms are very severe, a little raw pounded meat, may be given; but even in them the chief reliance must be placed upon thoroughly good milk, in sufficient quantity, and cod-liver oil. A certain amount of fresh fruit occasionally (the juice of an orange, baked apples, or well-cooked potatoes) is of value, not only by assisting digestion, but by giving variety and checking any scorbutic tendency.

Fresh air, light, friction at night with oil and bathing (with sea salt if it can be procured) are almost as essential. The body should be kept warm, without being overclad; and especial attention should be paid to this at night, for fear of chills. Slight degrees of deformity may be trusted to get well of themselves; for them splints are of very questionable value; put on in whatever fashion they may be, they never can prevent an active child, conscious of recovering its strength, crawling about and propping itself up. In severer cases it is a different matter; in these they may be of service, not to put pressure on the limbs (this is only possible in cases of lateral bending, and even then very little can be done, owing to the delicacy of an infant's skin), but to keep the child quiet; and they should be suitably contrived for this. Bad cases of knock-knee, for example, may be placed in a box-splint with weight extension; but the apparatus must be removed at frequent intervals, that the limbs may be thoroughly rubbed and washed and the circulation through them encouraged. It is extraordinary the effect that simple rest in bed, combined of course with food, fresh air, cod-liver oil, rubbing and sea bathing, has upon the deformity of an infant's limbs. The health does not suffer in the least from the confinement; the muscles do not waste; the strength, instead of being impaired, seems to increase at an unusually rapid rate; and the weight being taken off the limbs, the bones and joints begin to straighten themselves out at once. Even in advanced cases, in which the thickening of the epiphysis and the beading of the ribs are less prominent than they were, the same may be tried with benefit for a time: if, however, the bones are definitely set and the sclerosing process is complete, it is rarely possible to correct the deformity without an operation.

Acute Rickets

Under this name a class of cases has been described by Barlow and others differing from ordinary rickets in several particulars, and probably associated with scurvy. It only occurs in artificially fed children, generally in the course of the second year; and it is characterised by the presence of extensive sub-periosteal hæmorrhages, particularly on the femur, but involving other bones as well, even the beads upon the ribs. Later, when the acute stage is passed, the bones become enormously thickened, in all probability from the formation of a new periosteal shell around the extravasation. In some cases purpuric patches have been noted upon the skin; in others there were ecchymoses under the conjunctiva or in the eyelids; and in one the whole intestinal tract showed deep purple stains under the peritoneum, due to extravasation into the solitary glands and the adenoid tissue of the mucous coat.

The symptoms are very much more severe: in some cases they appear suddenly, in others they supervene upon the ordinary ones. The child is completely taken off its legs and lies flat upon its back, with the lower limbs slightly flexed and everted, utterly unable to move them (pseudo-paralysis). The pain is extreme; the thighs, which are usually the most affected, are swollen, tense and shining; the skin is pale, but often warmer than natural, and the tenderness is so great that the child begins to scream as soon as anyone approaches. The femur feels immensely thickened, and later, when the surrounding swelling has subsided, and the muscles are wasted, a dense solid casing can be made out around the bone, either extending over its whole length or chiefly localised at the junction of the epiphysis with the shaft. Soft crepitus can often be felt at the same time, as if the epiphysis was detached. The legs may be affected as well, and even the bones of the upper extremity, but rarely so badly. Before the disease commences there is usually very great fretfulness; the anæmia is extreme; the muscles waste; the gums are swollen and spongy in a large proportion of cases, especially around any teeth that are newly cut; there is a putrid odour about the mouth; and not unfrequently marks of bruising can be seen on the body.

The prognosis of these cases is exceedingly grave; the same treatment must be carried out, the limbs being protected from pressure and injury as far as possible. In one instance an excellent result was obtained by cutting freely down on to the bone, removing the blood-clot and draining the cavity. It does not appear to have been followed by further hæmorrhage.

OSTITIS DEFORMANS

This name was given by Paget to an affection in which certain of the bones of the skeleton successively undergo a peculiar form of enlargement. It may commence in one, generally the tibia, or in several; as a rule, it progresses slowly but steadily until all are more or less involved, the bones of the face and the hands and the feet being the latest. It is much more common in men than women; rarely begins before late in adult life; and may be symmetrical, though this is seldom exact. Respiration and locomotion are interfered with to a certain extent: the former by the changes in the spine and the thorax, the latter by the size and weight of the bones; so that the health frequently suffers, and patients have the aspect and attitude of extreme old age; but unless secondary complications occur it does not appear in any way to shorten life. In three out of the first five cases described by Paget, malignant disease of some type set in; and this has been observed by others, though not to the same extent. Whether there is any connection is doubtful; sarcoma and carcinoma have both been met with, sometimes involving the bones themselves, sometimes attacking other parts of the body altogether.

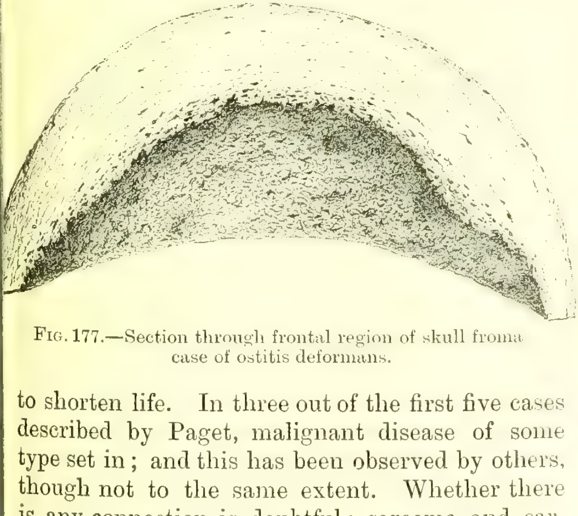


FIG. 177.—Section through frontal region of skull from a case of ostitis deformans.

The vault of the skull becomes enormously thickened, and at the same time uniform in character, the diploe disappearing completely (fig. 177). The long bones increase in all their dimensions (fig. 178); they become longer, thicker, and more irregular on the surface; at the same time they bend, and the curve involves the whole of the shaft, not, as in rickets, the weakest part only. The spine sinks down in a most peculiar way, the head falling forwards, and the back and loins forming one long uniform curve, with the convexity backwards. The thorax becomes rigid and distorted, so that the chest appears peculiarly short and narrow; and the pelvis widens out from side to side and diminishes from above downwards.

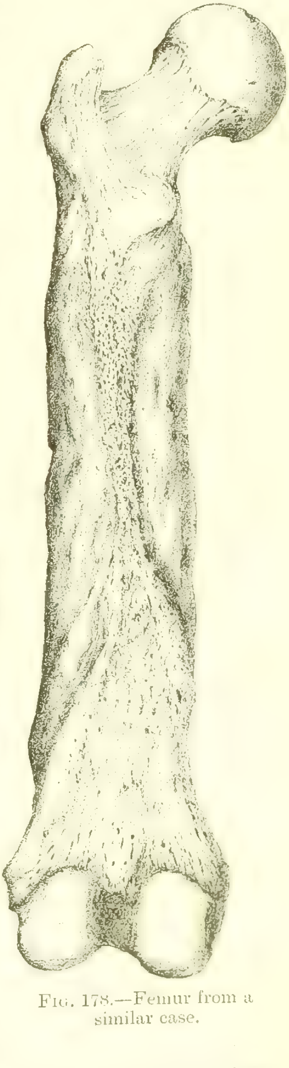


FIG. 178.—Femur from a similar case.

The structure of the bone is at the same time profoundly changed. At first there must be a certain degree of softening to account for the alteration in shape; but this condition has not yet been identified. The compact tissue of the shaft and at the ends is especially affected and is replaced almost altogether by irregularly developed cancellous substance. The medullary canal is filled up more or less, and the periosteal surface is roughened and irregular.

The microscopic appearances are practically the same as in rarefying ostitis. The Haversian canals are enlarged and their walls eaten out with Howship's lacunæ; the innermost layer is soft, staining readily with logwood, and the medulla inside resembles that found generally in inflamed bone, only it is more fibrillar and less rich in cells. The bone-corpuscles are irregular in their distribution; the lacunæ small, shrunken, and provided with but few processes; and the concentric lamellæ exceedingly uneven in their arrangement; but there is nothing in any way distinctive and there is no change in chemical constitution. Here and there evidence of formative ostitis may be found, in the shape of greatly reduced Haversian systems. Sometimes it is associated with rheumatoid arthritis round the joint ends, but it does not appear to be connected with it. Bones in this condition have been known to break and to unite again without difficulty. No visceral lesions of any kind have been found, and there is no alteration in the urine.

Cause.—Nothing is known with regard to the cause of this complaint. It appears to be much more common in England, especially in London, than elsewhere, but in all probability this is accidental. Gout has been found to exist in some, but by no means a large proportion. In one or two instances it has apparently originated from injury; in others it has been associated with exposure to cold and damp. Certainly it is more common in infirmaries than is generally believed. It is peculiar that such a large proportion of the earlier cases should have ended in malignant disease; but as there was no uniformity as to kind or even situation, this must probably be regarded as an accidental complication.

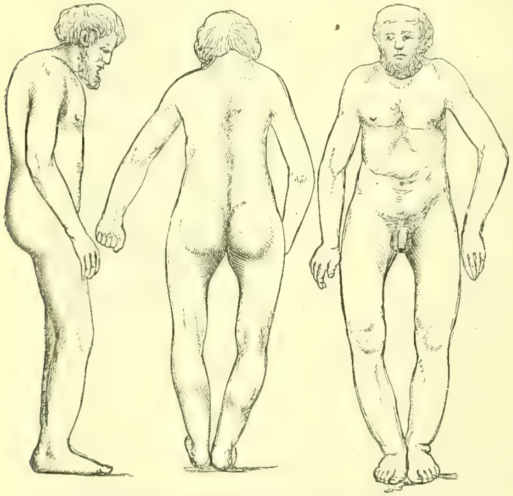


FIG. 179.—Attitude of a man suffering from ostitis deformans (Bryant).

Hutchinson regards it as an infective ostitis excited by injury. It is distinctly inflammatory, usually originates in one bone, is not exactly symmetrical, and, what is especially important, becomes more rapid and involves other bones more extensively in proportion to its duration. At first the onset is slow, the changes very gradual, and the number of bones attacked few; later it spreads much more rapidly. For purposes of illustration, Hutchinson compares it with the disease known as granuloma fungoides. This begins as one isolated patch; progresses slowly at first; after a time leads to the production of others, and finally becomes malignant. It has been suggested on the analogy of acute multiple periostitis, in which secondary abscesses form one after the other on distant bones, that the products of inflammation of any tissue are, when circulating in the blood, infective to that tissue throughout the body; and the greater the number of centres for infection the more rapid the spread and the greater the risk of contamination.

Symptoms.—At first these are very obscure. Vague pains are complained of in one of the bones, not especially nocturnal or periodic in character, but sometimes in the early stages rather severe. The head is never affected by them; it simply increases in size, so that a larger and larger hat becomes necessary each year, without anything else being noticed. Then a certain degree of enlargement, generally a bowing forward of the tibia, is detected, and after perhaps an interval of years, one bone after another becomes involved, until the whole skeleton is distorted.

In advanced cases the attitude and aspect are characteristic (fig. 179). The skull is massive and of enormous size, the head is carried forwards and lowered until the chin is an inch or more below the top of the sternum. The neck is shortened, rigid, and bent forwards, so that it is impossible for the patient to look up. The diminution of height is most striking; the whole spine is sunken and bowed, and even six inches may be lost. The shoulders are raised and very round; the arms appear of immense and disproportionate length, so that the hands reach below the knees. The chest is short and narrow, the abdomen broad and protuberant; and respiration entirely diaphragmatic; or, if a very deep breath is taken, the whole of the upper part of the trunk is raised. The lower limbs are strangely thickened, curved outwards and held apart, one usually a little in front of the other; the toes are turned out; the ankles overhung by the legs, and the gait slow and awkward.

Diagnosis.—In the early stage the symptoms very closely resemble those of rheumatic ostitis, but the pain is rarely so severe; afterwards the deformity is characteristic. Enlargement of the bones, sometimes attended with bowing (especially in the leg), is met with under other conditions, but the diagnosis is rarely difficult. Simple hypertrophy, for example, without alteration in proportion, is not uncommon in the young, arising from overuse or from lymphatic obstruction; and great overgrowth may occur in inflammation, dependent upon necrosis, syphilis, &c.; but the structural changes in the bones, the conditions under which they occur and the course they pursue, are entirely different.

In osteomalacia the skull sometimes becomes increased in size, but it is brittle, soft, and light, with abundance of medullary substance. A similar condition has been met with in rickets, very rarely in man, commonly in animals (Bland Sutton). The bone is described as becoming enormously thickened, but it is light, almost friable, and not porous on the surface; when touched it feels like fine cloth or felt. The membrane bones in particular are affected, and the change is not limited to the skull, but extends to the face, leading to closing of the orbits, filling up of the antrum, and atrophy of the optic nerves from pressure in the optic foramina. In leontiasis ossea, the growth, which usually involves the jaws as much as or more than any other bone in the head, is more irregular, and partakes rather of the character of exostosis than of simple enlargement.

So far as treatment is concerned nothing that is yet known appears to have the least effect. Iodide of potash is entirely useless, even for relieving pain; fortunately this is rarely severe and the disease does not appear to shorten life.

OSTEOMALACIA—MOLLITIES OSSIUM

This is a disease of adult life, in which the bones become softened to such an extent that they may be bent in almost any direction. It is very much more common in women than in men, and appears in many instances to be associated with child-bearing, especially with frequent pregnancies. Often it commences during the course of one of them, or shortly after child-birth; and when it occurs under these conditions it nearly always attacks the bones of the pelvis and the lower part of the spine. Under other circumstances the lower extremities are usually the first to suffer; and occasionally it remains limited to them. In most it involves one part after another; the patient becomes absolutely helpless; the cranium is thickened; infractions of the ribs and the bones of the extremities occur; and the walls of the thorax are softened to such an extent that respiration can hardly be carried out.

Osteomalacia is apparently an affection of the medulla occupying the central space and the Haversian canals. It seems at first to be converted into a small round-celled growth, so vascular that hæmorrhages take place in it everywhere. The bone in contact with it is softened and removed; the earthy matter disappears; the organic matrix is left with only a faint indication of lacunæ or canaliculi; and this in its turn undergoes a kind of gelatinous transformation until there is nothing but a soft thin shell under the periosteum, filled with a pulpy substance incapable of the least resistance. Sometimes this is so mixed with blood that it forms a reddish-brown semi-solid mass, resembling the substance of the spleen; in the later stages it undergoes fatty degeneration and becomes converted into a pale yellow gelatinous material containing large quantities of serum.

Nothing is known with regard to the cause; it appears to be endemic in certain localities, but sporadic cases, especially those affecting the pelvis, occur everywhere. Great general nervous depression is stated to have been present in a large proportion before the softening showed itself. No certain visceral lesions have been found, and with the exception of the urine, which at certain periods of the disease is loaded with lime salts, even forming calculi, there are no symptoms other than those that result from the softening of the skeleton and the consequent deformity.

Deep-seated aching pains, not unlike those due to rheumatism, are usually present, and as a rule are worse at night and after exercise. At the same time there is a sense of weakness and of inability to make any exertion; standing particularly is attended with pain; but there is nothing definite and no diagnosis is possible, until some alteration in shape is detected. The particular kind of deformity depends upon the circumstances of the case: the sides of the pelvis and the promontory of the sacrum may be crushed together until the cavity is almost obliterated; the spine may be bent almost double; the ribs and the walls of the thorax driven, and perhaps broken in, until the arms lie in two great hollows; or the bones of the extremity softened to such an extent that they can be made to assume any direction with the least pressure.

The disease does not appear to shorten life, except by the complications it causes. In a large proportion of cases death has occurred in connection with parturition; occasionally, when the skull has been involved, cerebral symptoms have set in; more frequently, owing to changes in the spine and ribs, respiration has gradually become more and more difficult, until at last hypostatic congestion and pneumonia have followed; and in a few paraplegia has occurred. If no complication of this kind makes its appearance the health gradually becomes more and more impaired from confinement and interference with digestion and the other functions of the body, until at length the patient sinks from exhaustion. Occasionally the disease remains stationary for a long time, and some instances of recovery, especially when it has been limited to the pelvis, are known; but no treatment appears to have any effect upon it. Recently, however, a case has been reported in which the symptoms disappeared after the ovaries had been removed.

A few cases are recorded in which osteomalacia has occurred in childhood (Davies-Colley) and in infants (Rehn). The diagnosis from rickets is in such circumstances exceedingly difficult; and this has led some to the opinion that the two diseases are essentially the same, occurring under different conditions. In osteomalacia, however, there is no enlargement of the epiphyses or periosteal thickening, as in rickets; and the course of the disease and the effect of treatment are entirely different.

TUMOURS OF BONE

Tumours of bone are either simple or malignant, though the degree of their malignancy varies within very wide limits. The former comprise the fibromata, osteomata and enchondromata, springing from the substance of the bone itself or the tough tendinous layer of the periosteum, and composed of what might be called adult tissues; the latter are all of them sarcomata, round-celled, spindle-celled, myeloid, or mixed, without any predominant element, and arise either in the soft vascular medulla (central or interstitial) or in the corresponding tissue in the deeper layer of the periosteum.

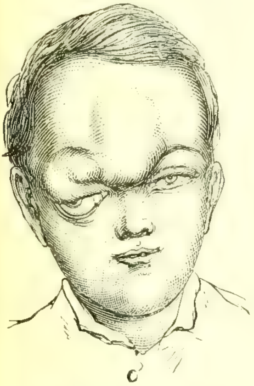


FIG. 180.—Exostosis of frontal sinus.

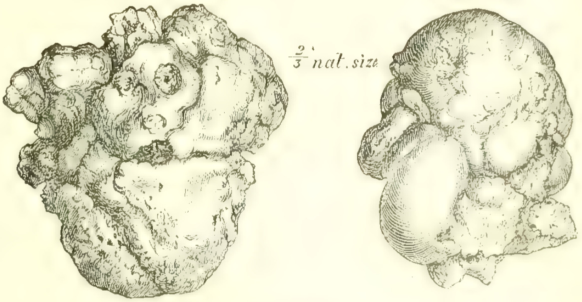


FIG. 181.
Ivory exostosis from frontal sinus.

OSTEOMA

Exostoses are of two kinds, ivory or cancellous. The former, which are chiefly developed in membrane, spring from the compact tissue of the flat bones, especially those of the skull, and are so named because of their density; their structure is that of true but exceedingly compact bone. As a rule they are single and limited in size; but occasionally, especially when they occupy the frontal or nasal sinuses, they attain very considerable dimensions and cause the most terrible deformity (figs. 180 and 181). Even when they are quite small they may, from their position, in the external auditory meatus for example, give rise to very serious inconvenience and even death.

Cancellous exostoses, on the other hand, are generally met with on the long bones. In many cases they are multiple and symmetrical, and then they are not unfrequently hereditary. As a rule they occur in childhood, at the junction of the epiphyses with the shaft, especially in the neighbourhood of the knee-joint, and they continue to grow until the ossification of the bone upon which they are placed is complete. Generally they stop then, but occasionally, when they have appeared rather later than usual, they continue to increase, and, unless they are dealt with, form tumours of very serious dimensions. Unlike the ivory ones, they are developed from cartilage which gradually becomes converted into cancellous tissue, continuous with that of the bone beneath. So long as they are growing a thin layer persists upon the surface like a cap; afterwards it becomes ossified and converted into compact tissue continuous with that of the shaft.

Single exostoses are frequently met with upon the linea aspera of the femur and the supra-condyloid ridges of the humerus, originating apparently in the fibro-cartilaginous tissue that marks the attachment of muscular aponeuroses. Very often it is difficult to distinguish them from osteophytes, outgrowths in the same region caused either by injury or by rheumatic inflammation. Another very common situation is the dorsal surface of the last phalanx of the great toe, where they give rise to the greatest inconvenience, from the way in which the nail is lifted up, first into a vertical position, and then farther still, until it grows back upon itself. Curiously, this particular form is much more frequently met with in women than in men (fig. 182).

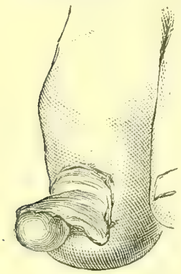


FIG. 182.
Sub-ungual exostosis.

Symptoms.—An exostosis, unless it presses upon some adjacent structure, merely forms a hard, painless enlargement of exceedingly slow growth. Not unfrequently a bursa is developed over it from the constant friction, and this may increase in size until it forms a communication with the neighbouring joint. In other cases, however, the growth may prove a very serious matter. The eyeball may almost be forced out of its socket and the face hideously distorted by one growing from the frontal sinus or antrum. The external auditory meatus may be closed, so that the secretion collects behind and sets up inflammation. The brachial plexus may be pressed upon by an outgrowth from the transverse process of a vertebra. Cerebral symptoms may be caused by one lying on the inner surface of the skull. The use of a joint may be rendered impossible. The pericardium may be pierced by one growing from a rib, and in short there is hardly any structure near a bone that may not suffer.

Treatment.—In one or two instances an ivory exostosis has separated spontaneously; probably the bone at the neck became so dense that the blood-vessels were gradually obliterated, and it was shed like the antler of a stag. Such an occurrence, however, is rare. Whether it is advisable to attempt removal must depend entirely upon the symptoms; if there is no inconvenience it should certainly be left alone, as the operation, even though the neck of the growth is often very much smaller than the body, is not one to be undertaken lightly.

Many are so hard that it is impossible to make any impression upon them with an ordinary trephine. On several occasions they have been removed, only after the most intense suffering and repeated operations, by constantly applying acid to the base, so as gradually to cause necrosis. Probably the most effective instrument for the purpose is the surgical engine with well-tempered steel drills, made to suit each condition. In the case of the external auditory meatus, for example, they should be guarded so as not to pass too far down. It is scarcely possible for any growth to resist this applied under an anæsthetic, but it is as well to have a series of instruments at hand.

Cancellous exostoses generally stop growing when the skeleton becomes developed, but if an operation is necessary, the neck can, as a rule, be divided easily with a chisel. Various kinds of cutting forceps, and occasionally a chain saw, may be required. Removal of the cartilaginous layer only in most cases is sufficient to stop the growth, but if the tumour presses upon adjacent structures it is better to take it away entirely. Subcutaneous fracture or section of the neck has been recommended, and sometimes after this the growth atrophies and disappears, but not unfrequently, in spite of all precautions, union takes place again. In the case of the subungual exostosis an incision should be made horizontally round the anterior end of the projection, and the nail with its matrix reflected; the growth can then be excised and the nail replaced in its natural position.

ENCHONDROMA

Cartilaginous tumours grow from the long bones at the junction of the epiphysis with the shaft, from the phalanges and metacarpal bones of the hand (the foot more rarely), and from some of the flat bones, especially the pelvis and scapula. Not unfrequently they are multiple. In some cases they originate in the centre and cause the bones to expand evenly into a thin shell, which ultimately disappears in places; more often they grow from some point in its substance or immediately under the periosteum (fig. 183); occasionally there are several separate foci, and in some exceptional instances the tumour appears to be diffuse, involving more or less the whole structure of the bone at one point. In addition enchondromata sometimes originate from the exterior of the periosteum and by their pressure cause absorption of the bone on which they lie.

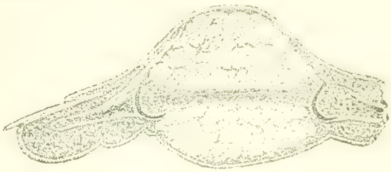


FIG. 183.—Enchondroma springing from surface of shaft of phalanx.

Some are composed almost entirely of hyaline cartilage, with but little fibrous tissue, and soon become ossified into cancellous exostoses. Others, especially those on the phalanges, become calcified in parts, or converted into mucous tissue, or undergo cystic degeneration, so that they are filled with cavities containing a thin glairy fluid. Their growth is always exceedingly slow. If, particularly in the case of a tumour attached to the surface of a flat bone, progress is at any time rapid—if, for example, it has doubled its size within the year—it must be regarded with very grave suspicion, as it is very likely to turn out, not a true enchondroma, but a chondrifying periosteal sarcoma, the prognosis of which is exceedingly bad.

Enchondromata are much more common in the young than in the old, often they have lasted for years already before any attention is paid to them, and occasionally, especially when they grow from some inconspicuous place, such as the pelvis, they are allowed to attain an enormous size. They form smooth, rounded or slightly lobulated swellings, the outline of which, though it may shade off into that of the subjacent bone, is always free from the other structures around; the skin and the muscles may be made to move over it without difficulty. Usually it has the peculiarly firm, elastic resistance of cartilage, but sometimes bony plates may be detected on the exterior, and occasionally it is plainly cystic. Central growths are fusiform in shape and no line of separation from the bone can be made out; sometimes parchment crackling can be felt. Superficial or peripheral ones are more distinctly rounded, projecting from the bone beneath, and if there is a pedicle are often slightly movable.

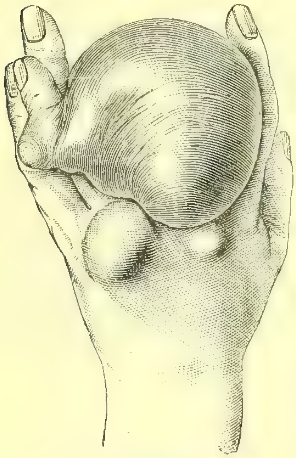


FIG. 184.—Enchondroma of hand.

Except in the case of intrapelvic tumours the diagnosis rarely presents any difficulty. The most important feature is the extreme slowness of growth; unless some nerve is caught and compressed all the surrounding structures are gradually and painlessly pushed aside. Syphilitic or strumous enlargement occasionally presents a certain amount of resemblance, especially in the case of the fingers; but though it may not be very distinct, there is always some evidence of inflammation in these cases.

The prognosis, so far as the character of the growth is concerned, is very good; there is little doubt that the cases formerly described, in which secondary deposits made their appearance within a comparatively short time, were really sarcomata, in which the greater portion of the growth had become converted into cartilage; but very great inconvenience and even danger may arise from the size, number, or situation.

The only treatment is the removal, if possible, of the whole growth, though in some cases portions have been left behind without causing further trouble. Whether this should be attempted or not must depend upon the circumstances of each case: if the tumour is not increasing in size, or is not in such a situation as to cause inconvenience or danger, it may be left, provided the patient is aware of the necessity for careful watching. When it is situated on one of the fingers it is often possible to excise the growth, leaving the bone from which it springs; even though there is merely a shell, it will become sufficiently consolidated to act as a support. If this cannot be done, and the growth is very unsightly, the finger must be amputated. The same plan may be followed with the large single enchondromata occurring in other parts of the body: either excision or amputation, according to the situation of the growth and the condition of the parts left after its removal; but occasionally, especially when it grows from the pelvis, this may be a matter of the very greatest difficulty; in one instance, for example, it became necessary to place ligatures upon the common and external iliac arteries and veins before the tumour could be removed.

FIBROMA

Tumours composed simply of fibrous tissue are rarely met with, except in the form of naso-pharyngeal polypi, growing from the under surface of the base of the skull, and epulis springing from the alveolar border of the jaws. With a few exceptions they are always attached to the periosteum, and are more or less pedunculated. The diagnosis from enchondroma is rarely possible before removal. Fibro-sarcomata may be distinguished by their greater rapidity of growth.

SARCOMA

Probably all primary malignant tumours of bone belong to one or other of the varieties of sarcoma. Carcinoma never occurs except from secondary infection or direct extension. Like other sarcomata, they are met with at all ages, but are much more common in early life, and they are distinguished from all other tumours of bone by the rapidity of their growth. In many instances they originate after, and possibly because of, local injuries.

There are two forms fairly well distinguished: one growing from the deeper layer of the periosteum, the other from the medulla, either of the central canal or of the cancellous ends. In addition periosteal growths are occasionally met with, originating from the exterior and extending into the substance of the bone. Few are composed of only one tissue, nearly all are mixed; but, as a rule, one kind predominates sufficiently to admit of their being classified as round-celled, spindle-celled, and myeloid or giant-celled. Secondary changes are often present as well: ossification and chondrification, for example, are not uncommon, especially in periosteal growths; myxomatous and cystic degeneration are of frequent occurrence in the central; hæmorrhages may be caused by the most trivial degrees of violence, owing to the thinness of the walls of the vessel; and the extravasation is sometimes so extensive that nothing but a shell of solid tissue is left around the exterior.

The bones of the lower extremity are very much more frequently attacked than those of the upper, and the neighbourhood of the knee-joint is by far the favourite locality; but they are common upon the jaws (forming one variety of epulis), and they may occur upon any bone in the body.

Their malignant character is shown by the way in which they infiltrate the structures around, implicate lymphatic glands, and occasion secondary deposits in other organs, especially the lungs. In this respect, however, they present considerable differences. Central ones, for example, confined within a shell of bone, are much less prone to extend than periosteal; lymphatic enlargement is much more unusual in the spindle-celled variety than in the round-celled, and it is much more likely to occur in sarcomata of the pelvis than in those growing from any other part of the body.

Spindle-celled periosteal sarcomata are the most malignant, giant-celled central ones the least so.

1. *Central Sarcomata*

These grow from the articular ends of long bones or the cancellous tissue of short ones. Sometimes they simply remove and replace the bone, keeping exactly to the shape and size, so that the first definite sign is spontaneous fracture; more frequently they cause gradual expansion, the compact tissue being absorbed from the interior, and a new deposit being laid down under the periosteum, until at length a great shell is formed, more or less spherical in shape, smooth on the surface and covered over with thin bony plates, which give a sensation of egg-shell crackling when pressed upon. The rate of growth is less rapid than that of the periosteal variety, but at length the casing givės way and the overlying soft tissues are invaded. The articular cartilage resists to the last, so that after the bone is removed it floats as it were upon a soft yielding bed, incapable of withstanding the least strain; but unless it is torn accidentally it very rarely gives way of itself. Pain is often severe, especially at night; pulsation has been noticed in a large proportion, and spontaneous fracture is not unfrequent.

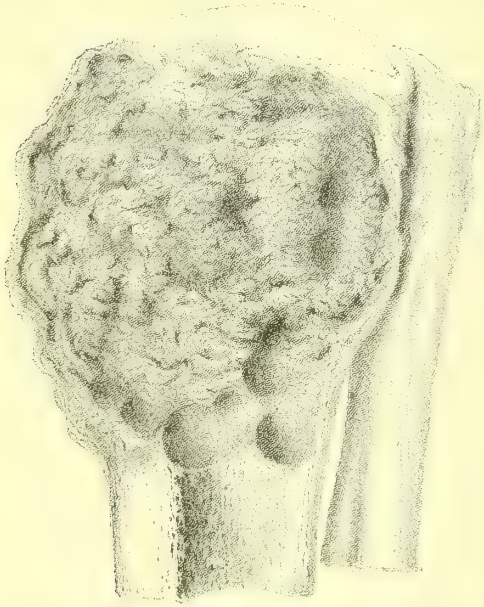


Fig. 185.—Central myeloid sarcoma of upper end of tibia. The articular cartilage on top is intact. Below are many cysts.

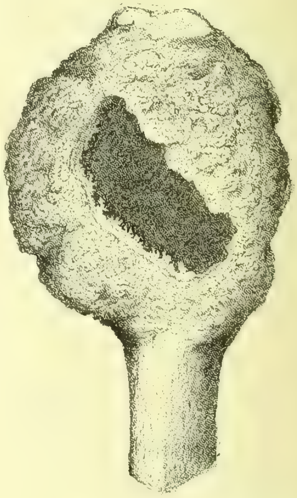


Fig. 186.—Myeloid sarcoma of upper end of fibula, causing immense expansion of bone. The interior contained apparently nothing but blood until the wall was scraped.

Giant-celled, round-celled, and spindle-celled forms may all occur; but the first is the most striking in appearance. Dark red, brown, or maroon-coloured masses of myeloid cells are mixed here and there with whiter parts, in which the round or spindle cells predominate. Cysts are scattered all through the substance of the tumour, some containing a perfectly clear fluid, others filled with a soft greenish jelly-like material, the product apparently of myxomatous degeneration; (fig. 185) while here and there blackened patches from old hæmorrhages, or bright red ones from those more recent, add to the general variety. In some instances, which used to be described as blood-cysts, the hæmorrhage is so extensive that there is merely a thin bony shell filled with extravasated blood and lined with a film of sarcomatous tissue (fig. 186).

The spindle-celled form has a tendency to attack the shafts of the long bones rather than the cancellous extremities, and assumes the shape of a rounded tumour, generally firm and elastic to the touch, and greyish-white and smooth in section. From its position it is peculiarly liable to lead to spontaneous fracture; local pain is felt for a week or two in the shaft of one of the bones, sometimes very severely; fracture suddenly occurs without any adequate reason; and a rapidly growing tumour forms at the seat of injury. It is in these cases that the diagnosis from quiet necrosis is so exceptionally difficult.

Round-celled sarcomata, when they occur in the medulla, are only to be distinguished from myeloid ones by their greater rapidity of growth; consequently in them the pain is more severe, pulsation more frequent, and the tendency to hæmorrhage and invasion of surrounding parts more distinctly marked.

2. *Periosteal Sarcomata*

These are either round-celled, or spindle-celled in varying proportion: sometimes almost pure, sometimes evenly mixed. Giant-cells are generally present in the deeper parts, but not in sufficient number to form a separate class. Many of them are converted to a greater or less extent into cartilage or bone; and it is probable that most, if not all, the tumours formerly described from their malignancy as osteoid cancer, malignant enchondroma and the like, were really periosteal sarcomata. They spring from the deeper, more vascular layer; and the tumour at first is confined to one side of the bone. The fibrous part is stretched over it so long as the growth is small; but as soon as it attains any size it bursts through this, invades the tissues around, and destroys everything, including the superficial portion of the bone (fig. 187). Sometimes it extends into and rapidly fills up the central canal.

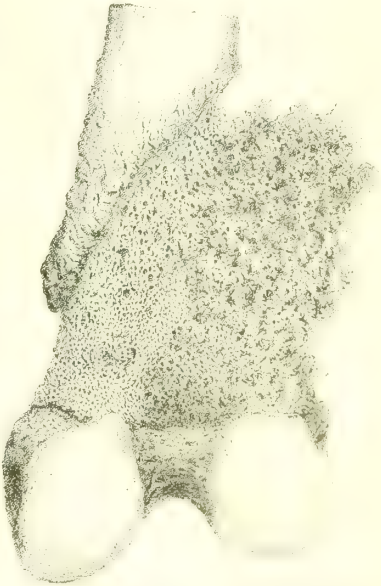


FIG. 187.—Skeleton of a periosteal sarcoma growing from lower end of femur; the epiphysis is not yet united.

The consistence of the growth is very variable. In many instances it is simply a soft pulpy mass filled with broken-down extravasations; in some it is much firmer and almost fibrous on section. The base is often partially converted into cartilage or bone; and the whole of its substance may be traversed by delicate osseous trabeculæ springing from the bone beneath, and forming a most elaborate skeleton. Cystic and gelatinous degeneration also occurs in patches here and there.

Periosteal sarcomata appear to be more common in the femur than elsewhere, commencing either on the shaft or the epiphysis; but there is no bone in the body that is exempt. They are all of them of the most intensely malignant character, affecting not so much the lymphatic glands (spindle-celled ones very rarely) but other distant organs; so that even if amputation is performed as soon as the diagnosis is made, the stump may remain healthy to the last, but secondary growths are almost sure to appear within the twelvemonth. The liability to fracture of course is less than in the central variety; but the other signs due to the extension of the growth into the structures around are, as a rule, more distinct.

Symptoms.—In the early stages these are very indefinite. Pain is rarely absent; often it is very severe, especially at night. In the periosteal form a distinct swelling, projecting from one side of the bone, is one of the earliest symptoms; in the central it is rarely perceptible until the disease is far advanced; and when the growth commences in the interstitial medulla at one of the cancellous ends, it is often entirely absent until the whole framework has disappeared. The outline of the enlargement is fusiform, spreading along the bone and ill-defined in the periosteal; in the central it is rounded and more distinctly limited. Its consistence is equally variable: sometimes it is soft and fluctuating; sometimes hard and dense, according to the character of the predominant tissue. Egg-shell crackling is only met with in the central variety.

Spontaneous fracture may occur in either, but it is less common in the periosteal. Occasionally it takes place without any evidence of tumour or new growth except pain; but the swelling rarely fails to make its appearance immediately after, and soon attains an enormous size.

Rapid growth, enlarged cutaneous veins over the tumour, softness, and above all pulsation, are most important. Any tumour attached to bone that doubles its size within six months must be regarded with very grave suspicion, particularly if it occurs in a young person and in the neighbourhood of the knee-joint. Pulsation is present in a large proportion of central sarcomata, and in periosteal ones, when they grow from the flat bones; and when it occurs it is practically definite. It is entirely different from the heaving impulse of an aneurysm; and though it may be accompanied by a distinct thrill and bruit, these are only present over a small portion of the swelling. The pulse in the limb below is unaffected unless the tumour compresses the main artery against the bone; and the swelling cannot be materially lessened by pressure.

If the diagnosis is uncertain the swelling should be explored without delay with a fair-sized trocar and cannula. In many cases this penetrates into the bone in such a way that there can be no doubt as to the change it has undergone: in others, myeloid cells, or other structures that can be recognised as sarcomatous, come away with the blood and can be recognised under the microscope.

Diagnosis.—Innocent tumours of bone are distinguished by the slowness of their growth, and by the absence of pain and increased vascularity.

Gummata occasionally present some difficulty, as the history of syphilis does not exclude the presence of sarcoma. Any doubt, however, can usually be dispelled in a few days by the administration of iodide of potash. It relieves the pain of sarcoma, so far as this is dependent upon accompanying periostitis, but it has no effect upon the size.

When the sarcoma occupies the cancellous end of one of the long bones it may be entirely concealed by the symptoms of inflammation of the neighbouring joint. This chiefly occurs at the knee: the position of the limb is characteristic of disease of the joint; movement is painful and limited; the synovial sac is filled with fluid; and though the lower end of the femur or the upper end of the tibia is replaced completely by a new growth, there is no enlargement of the bone. The same mistake may easily occur in the acute suppurative arthritis of infants, especially as rapidly growing sarcomata, such as simulate abscesses, are often attended with a typically hectic temperature.

Chronic inflammation of bone, with the formation of a sequestrum (quiet necrosis), is most deceptive, especially when the shaft of one of the long bones is concerned. Even after spontaneous fracture has occurred it is sometimes impossible to make a diagnosis without free exploration.

A few instances have been recorded of pulsating tumours of bone without any sarcomatous growth (osteo-aneurysm); such, however, are very rare. True aneurysm may sometimes cause a certain amount of difficulty, but in nearly every case the position, the relation it bears to the artery, the fact that the sac can be emptied by pressure, or the history, settles the question at once.

Treatment.—1. *Central Sarcomata.*—Excision may be practised when the structure of the part allows it, and the growth has not become diffused too widely. Thus, the upper end of the fibula may be completely removed, or part of the ulna; and the upper end of the humerus even has been treated in the same way, leaving a fairly useful limb. But all such cases must be very carefully watched, for fear of local recurrence.

Where this is not possible, amputation should be performed sufficiently far above the growth to make sure that the tissues are healthy, and if the bone is divided the cut surface of the medulla should be very carefully examined.

2. *Periosteal Sarcomata.*—For these, amputation is the only resource. If the growth is situated at the distal end of one of the long bones, and the disease is not of long standing, the operation may be performed through the shaft, at a sufficient distance above. Recurrence is very probable, but if the sawn section of the bone is healthy, it may not take place in the stump. When the disease is situated higher up, disarticulation should be practised, except in the case of the hip. Amputation at this joint for periosteal sarcoma at or above the middle of the bone is practically hopeless.

Portions of the clavicle have been excised successfully for central sarcoma; but when the growth is periosteal, or when it has invaded neighbouring structures, it must rest with the patient whether such an operation should be undertaken. Resection of the inferior angle of the scapula is not a serious or difficult matter, if it is done as soon as the nature of the tumour is recognised. The whole bone has been removed on some twenty occasions, with preservation of the arm; and more than once the whole of the upper extremity, with the scapula and part of the clavicle, has been taken away. Nearly all of these, however, have terminated fatally within the twelvemonth, from secondary deposits in the lungs.

Cysts

Hydatid cysts are occasionally found in bones; and chronic abscesses sometimes leave behind them smooth-walled spaces with clear contents; but unless they lead to great dilatation or to spontaneous fracture, they are not likely to be diagnosed.

Cysts, due to softening, degeneration, or hæmorrhage, are very common in connection with sarcomata, especially central ones; but, except some occurring in the jaws, which, owing to their special character are described by themselves, other forms are almost unknown.

Carcinoma

It is doubtful whether, in the absence of epithelial elements, primary carcinoma of bone can occur. Secondary deposits, however, are not unfrequent; cancer of the vertebræ, for example, may occur in scirrhus of the breast; and especially in the leg, over the subcutaneous surface of the tibia, epithelioma may gradually extend down into the substance of the bone.

Section IV.—Injuries of Joints

These, like injuries of bones, are divided into two classes. In the one there is no external wound; the skin is unbroken; the tissue-changes that follow are rarely more than is required for repair, and inflammation is never severe unless there is some additional irritant, such as gout or scrofula, to keep it up. In the other the interior of the joint is filled with fluid, and exposed to the air; decomposition may set in at any moment; and if it does, it is certain to cause an attack of inflammation, which is very likely to end in the destruction of the joint or place life itself in danger.

Wounds of Joints

Punctures and clean incised wounds are caused by stabs and cuts; lacerated ones are usually associated with compound fractures or gunshot injuries; but they may be produced by any crushing or tearing force, and may be of any extent, from a puncture, the very existence of which is doubtful, to a rent which lays open the joint from side to side. In many instances the diagnosis is clear at the first glance: the interior of the joint can be seen; or there is an escape of synovia, recognised, even when mixed with blood, by its peculiar glutinous feel; or the joint in a very few moments becomes distended with fluid. But in a few it is a matter of some difficulty, either from the nature and direction of the wound, or from the presence of neighbouring spaces, such as bursæ, tendon sheaths and cysts, which contain the same kind of fluid, and which sometimes do, and sometimes do not, communicate with the central cavity. If there is the least ground for suspicion, the case must be treated with exactly the same precautions as if the joint were really opened; and no attempt should ever be made to explore the wound with the probe or the finger merely for the purpose of making certain. This, of course, does not apply to any case in which the wound is dirty, or inflicted with a dirty instrument, or in which there is the least probability of such a thing; thorough exploration, then, is essential.

Pathological changes.—These are the same as those that follow other injuries; the danger arises from the size and complexity of the cavity, its extent of absorbing surface and the difficulty of draining it effectually. Suppuration rarely occurs in small joints, and extensive wounds often heal with the least disturbance, because the risk of decomposing material being confined under high tension is so much less.

Large vessels are not often divided, but the small ones bleed profusely, and often, before their orifices are closed, the synovial cavity and the loose spaces around are filled with blood. Then the edges of the wound become red and swollen, the vessels dilate, lymph pours out through their walls, the perisynovial tissues become infiltrated and gelatinous, and the cavity grows fuller and fuller. Soon the irritation spreads to the lining of the sac, the endothelium falls away, the surface loses its polish, the folds and fringes become hyperæmic and swollen, small extravasations take place here and there, especially along the line of attachment of the capsule, and the joint becomes distended with a turbid, blood-stained mixture of synovia and lymph.

The subsequent course depends upon the kind and the persistence of the irritant. If there is no tension or decomposition, if the only injury is that which was inflicted at the moment of the accident and no other is added, the hyperæmia soon begins to subside, the quantity of fluid diminishes, the swelling of the cellular tissue disappears, the cells on the surface of the synovial membrane gradually resume their normal character, the edges of the wound cohere together, and the joint is left sound, though weakened a little and inclined to be irritable for a short time.

If, on the other hand, the original hurt is not the only one, if it is supplemented by some other acting persistently on already damaged structures, the tissue-changes become excessive, altogether beyond what is needed for repair, and inflammation sets in.

The severity of the attack depends upon the nature of the irritant. Where it is merely high tension or want of rest, suppuration, though it may occur, is decidedly rare. The nutrition of the tissues is impaired, but they are still strong enough to destroy any pyogenic germs that may reach them. The joint continues painful and swollen after the wound has healed, the skin is warmer than natural, and even a little reddened; a certain amount of thickening is left, so that the synovial membrane does not unfold itself smoothly and easily as the joint moves; or the amount of fluid is excessive; a certain degree of inflammation, in short, persists, but it is rare for it to be dangerous or severe.

If decomposition occurs, the difference is very marked. The fluid with which the joint is filled at once becomes the most virulent poison; the whole of the synovial sac is involved; the hyperæmia and exudation spread wider and wider; stasis and thrombosis occur; some of the tissues perish at once; others, less severely injured, yield to the pyogenic microbes that find their way in through the wound or through the blood, and break down into pus; only those at a distance resist, and strive to limit the area of destruction by forming a wall of vascular granulations. The ligaments become soft and yield, so that one bone is displaced upon another; abscesses form in the cellular spaces around, either independently or by direct extension from the joint; the cartilages turn yellow and sodden; where there is pressure they fall off in large necrosed flakes, which bring away with them the articular lamella of the bone; at the margins they grow thinner and thinner until they look like pieces of wet wash-leather; the bones become soft and carious upon the surface, and the joint is utterly disorganised.

Symptoms.—These depend upon the size of the joint and the consequences that follow. If the wound heals at once, by the first intention, there may be nothing noticeable; but nearly always the joint is swollen and tender for the first few days; the skin is warmer than natural, the muscles are rigid, in order to keep the part at rest, and if the synovial membrane is large, so that there is rapid absorption, the patient is feverish and uncomfortable, though the rise of temperature is scarcely more than one or two degrees.

In other cases, the symptoms are more marked and the injury is followed by an amount of synovitis sufficient to cause a certain degree of anxiety. The joint is as full as it can be, the skin is red and even œdematous, the pain and constitutional disturbance are more severe; but even then, if the onset is gradual—if three, or, better still, four, days pass by without the symptoms becoming urgent—there is reasonable hope that the inflammation is due to other causes than decomposition, and that it will subside without running on to suppuration.

If decomposition does occur in the interior of one of the larger joints, the symptoms are generally beyond question. From the first few hours they are infinitely more intense, and they grow worse and worse with such rapidity that in the course of three or four days, if the case is left to itself, the condition of the joint is almost hopeless. Acute suppurative arthritis sets in with the utmost virulence. The edges of the wound are reddened and everted, and a thin, serous pus oozes out; the skin is dusky with enlarged veins running in it; it is boggy and œdematous, pitting deeply in places, and it almost scorches the hand. The swelling is no longer the shape of the synovial sac, it is more rounded and uniform; or it extends a greater distance along the limb, particularly on its inner side; the pain is intense, and is no longer of the same character; the joint burns or throbs as if it were bursting; it is held rigidly fixed in a position of semi-flexion; the slightest attempt at movement causes the utmost dread; and the fever is of the severest type, the temperature, if it is the knee, reaching 105° or even 106°, so that the patient becomes delirious. When rigors, or what are known as starting-pains, make their appearance, the prognosis is even more grave. The former may mean the onset of suppuration, or the beginning of pyæmia; the latter points to necrosis and destruction of the cartilages. Later, if the patient does not die from septic absorption, the fever alters its character, and as granulations are thrown out, assumes the hectic type, fresh abscesses, each causing a new outbreak, forming every now and then in the cellular tissue around. Finally, if the patient is not attacked by pyæmia or other complications, and does not sink from exhaustion, the constitutional disturbance gradually subsides as the wound becomes smaller, and the limb is left stiffened, wasted, and covered with scars.

Treatment.—Compound fractures into joints, compound dislocations, and wounds of joints accompanied by injury to important structures near, will be dealt with by themselves. The age and constitution of the patient, the size and importance of the joint, whether it is in the upper or the lower limb, and the extent of the injury sustained by the soft parts and the bones respectively, are the chief factors in determining what is to be done. The choice lies in each case between preservation, excision, and amputation.

In the case of a wound the first thing is to prevent decomposition. A simple incision, such as that inflicted by a surgeon for the removal of a foreign body, should be closed at once. If it is large a catgut suture may be inserted; if small, the edges may be brought together and sealed with collodion, or covered with iodoform, or closed with lint dipped in Friar's balsam. A lacerated or dirty wound, on the other hand, or one the condition of which is even suspicious, must be thoroughly and perfectly cleansed. Whether the joint should be washed out or not, depends upon the character of the injury and the length of time it has been inflicted; but if there is any doubt it should certainly be done, additional openings being made if the cavity is a large one. In the case of the ankle, wrist, and elbow, it is an excellent plan to immerse the limb bodily in a corrosive sublimate bath for an hour each day, syringing the joint out thoroughly through a piece of rubber tubing inserted into the wound. I have on several occasions treated compound fractures into the wrist-joint, and they perhaps are the worst of the three, in this manner with excellent results. If it is the knee, this is hardly practicable, and decomposition must be prevented in other ways. Washing out the joint, even with the most active antiseptic, is rarely enough: it is very difficult to make it penetrate efficiently into all the recesses, especially in the case of a person who is somewhat advanced in life: in children it may answer, as the shape of the sac is more simple. Constant irrigation is more likely to succeed, especially if commenced at once: the products of decomposition can hardly collect then; and Treves has shown that if it is thoroughly carried out, and kept up night and day, even with simple water, a knee-joint that has already begun to suppurate may recover with almost perfect mobility.

It is equally important to prevent tension and to secure perfect rest. A lacerated or contused wound should be left partially open and covered with a small piece of non-adhesive dressing, so that the exudation can escape at once; or if the synovial lining is very complex and ill-adapted for drainage, additional openings should be made, and tubes inserted into every pocket. When the knee-joint is concerned, the simplest way is to push a pair of dressing-forceps down through the wound, until it projects in the popliteal space, when a small incision may be made over the end, the tube grasped and drawn back again. Then the whole joint should be covered over with abundance of wood-wool or some other thoroughly absorbent dressing.

The limb must be placed upon a splint in the most comfortable position (always provided it is a suitable one) and fixed securely: it should be raised if possible, well bandaged, and kept cool by means of an ice-bag or Leiter's coils. The patient must be placed on low diet, the bowels well opened, and sleep and quiet ensured by opium or chloral.

The temperature is the best guide to the subsequent treatment. If there is only a slight rise and the pain about the joint is not severe, the wound should not be touched (unless drainage-tubes require to be taken away) until it is sound, the part meantime being enveloped in cotton-wool and well bandaged to prevent any distension of the capsule. If, however, the temperature rises more than one or two degrees, if the joint becomes distended and painful, particularly if it begins to throb, the condition is much more critical. Cold and compression with layers of cotton-wool may still be tried; leeches placed all round the joint; an ice-bag laid upon the main artery of the limb (the femoral has been tied for acute suppuration in the knee-joint); or even the joint aspirated to reduce the tension; but if the skin is boggy and œdematous, and if the swelling is diffuse, no longer confined to the synovial sac, it is very doubtful whether suppuration can be prevented. If there is not speedy improvement, the joint must be laid open freely on both sides (small incisions are worse than useless) and irrigated so thoroughly that retention of decomposing material is impossible. Then the limb must be fixed to a splint in such a position that if ankylosis does occur, it may still be of some service. Sometimes even after this the articulation recovers, especially in children, with a surprising degree of mobility. More often the severity of the inflammation subsides; granulations spring up; the amount of pus diminishes; organisation sets in; and fibrous or bony ankylosis results. Occasionally abscesses continue to make their appearance along the limb (under the quadriceps in the case of the knee), and either the patient sinks under the prolonged suppuration or amputation is performed.

Subcutaneous Injuries

Sprains and Contusions

Under this heading are included almost all injuries of joints that are not attended by permanent displacement of the articular surfaces. There may be merely a slight effusion into the capsule of a joint with a little stretching of some of the fibres; or the synovial sac may be filled with blood, the ligaments torn or wrenched off the bone, the muscles lacerated, the tendons displaced from their grooves and the tissues torn and crushed as severely as if it were a dislocation. In many cases the sole difference between a sprain and a dislocation is that, in the one, the bones, which are wrenched asunder at the time of the accident, resume their normal relation as soon as the force is spent; in the other, they either remain fixed where they are or slip a little farther aside.

Contusions are the result of direct violence, such as blows and kicks, and may be serious from the extent of the bruising, or from the tension set up by the blood that pours into the cavity of the joint. Sprains on the other hand are due to violent and sudden twists, wrenching the joint when the muscles are either tired out, or are caught unawares; probably, without this, they would very rarely occur. Astley Cooper said of dislocations that it was only possible for them to take place when the muscles were unprepared for resistance, and the same is nearly as true of sprains.

The *amount of injury* is very variable. In some there is only a spot or two of extravasated blood, just at the attached margin of the capsule; in others the joint, and the loose cellular tissue that extends along the bone and under the skin, are filled with it. Sometimes it is uncertain whether there is a rent or not; or the strongest ligaments in the body, such as the internal lateral ligament of the knee or ankle, may be torn in two. Nearly always when this happens they drag away with them a thin scale from off the bone. In severe cases the muscles always suffer, and sometimes they are extensively lacerated, possibly in the sudden spasmodic effort at recovery;

the tendon-sheaths are bruised and filled with blood; the nerves are stretched and torn; and even the bones show at times deep ecchymoses in their cancellous substance.

The pain at the moment is intense and of a peculiar sickening character, so that the patient may fall down fainting; later the part becomes numbed, with a dull aching sensation, due to the tension on the nerves. Swelling generally sets in at once, and the synovial cavity is distended to its utmost in the course of a few moments; but sometimes, when it is due rather to inflammatory exudation, it is more gradual, and does not attain its maximum for twelve or even twenty-four hours. The skin is exceedingly tender, especially over the spot where the ligaments have given way; the least attempt at movement is looked upon with dread; and discoloration soon begins to make its appearance. In the case of a sprained ankle, if there are many small varicose veins round the joint, the ecchymosis may reach as far as the knee in a very short time.

Recovery is often imperfect. Inflammation does not occur unless there is some other irritant as well, but very often the joint remains cold, stiff, and painful whenever an attempt is made to use it. This may be caused in various ways. Adhesions may have formed, binding tendons down to their sheaths, or even uniting two articular surfaces to each other; the capsule and the loose tissue around may have become dense and unyielding (especially on the inner side where it is soft and thrown into folds); the muscles may be matted together; or the synovial sac may remain distended; but in many instances nothing can be found. Movement is restricted and painful, at one spot in particular, but there is nothing out of place. There is a sense of weakness about the joint, so that it does not feel as if it could be trusted; or it becomes swollen whenever it is used; but there is no inflammation: the skin rather is unnaturally cold; it is smooth, glossy, and livid showing that the circulation through it is imperfect; the tissues, in short, are starved from prolonged inactivity; they are unable to work because they never get a proper supply of blood; and the only remedy lies in encouraging the circulation as much as possible.

Treatment.—Slight sprains, when the tissues are stretched rather than torn, are treated most successfully by massage and bandaging; but it must be carried out carefully and thoroughly. The limb must be raised, the muscles relaxed, and all constricting garments removed. At first the movement must be exceedingly light, and directed so as to diminish the sensitiveness of the skin, commencing above the injured joint, where the swelling has not yet shown itself, and working gradually nearer to it. The direction must always be towards the trunk; the thumb, or the tips of the fingers, or the palm of the hand, may be used, according to the shape of the surface; and the tender spots must be left to the last. If this is properly carried out, the swelling begins to diminish in a few minutes, and, as the circulation improves, absorption becomes more rapid, and the tendency to start and the involuntary shrinking disappear. Then more attention may be paid to the spaces in which the extravasated blood has collected; the tips of the fingers or the thumb may be made to trace out the irregular intervals between the bony prominences, moving round and round in small circles upon the skin; and gradually firmer and firmer pressure may be used, as the superficial structures become accustomed to it. This must be kept up until the effusion has almost disappeared, and slight passive movements, of such a nature as not to exert any traction on the injured ligaments, are allowed without resistance. Then the joint must be covered with several layers of cotton-wool, and compressed as firmly as possible with a flannel or a Domette bandage. Generally speaking, this has to be repeated for two or three days, but each time the sitting is shorter and less irksome.

In more severe injuries, where from the tenderness over certain spots it is clear that some of the ligaments have given way, the same plan may be tried; but naturally a longer time is necessary for repair. Heat and cold, if used with sufficient energy, are of excellent service as temporary remedies. They help to check the effusion by constricting the small vessels, but they do not assist absorption; and the sooner methodical compression is applied the better. Care of course must be taken that the pressure really falls upon the parts that need it—not, as for example, in the ankle, on the heel and the malleoli. Passive motion should be commenced as soon as the effusion is absorbed, on the second or third day. Even if the ligaments are torn, the joints may be moved gently through a very wide range, without throwing the least strain upon them. For this reason a fixed apparatus, such as plaster-of-Paris, should never be employed in sprains.

DISLOCATIONS

A dislocation is a sudden displacement of one of the bones of a joint from its normal position with regard to the rest. Gradual displacements, which result either from disease (pathological), or from malformation (congenital), are better dealt with by themselves.

Dislocations are said to be *complete* when the articular surfaces are entirely separated from each other, *incomplete* when they are still to a certain extent in contact, as usually happens, for example, in the case of the knee. They are *simple* if the skin is unbroken, *compound* if there is a wound exposing the interior of the joint; and the distal segment of a limb is always described as being displaced from the proximal. In older descriptions this rule was not always observed.

Causes.—These are either predisposing or immediate.

1. *Predisposing.*—Dislocations are met with at all times of life, from birth to old age, but with very different degrees of frequency. With the exception of the elbow-joint, they are much more common in adult life, because then the bones are at their strongest, and naturally they are more often met with among men than among women. But, independently of this, there is a certain class of persons in whom they are peculiarly liable to occur. The muscles are poorly developed, the bony prominences feebly marked, and the ligaments loose and yielding, so that the slightest force, if the muscles are caught unawares, is enough to cause displacement. Fortunately in many of these the capsule is not torn and the injury is really only a *subluxation*, but occasionally it gives way under the strain and the head of the bone is forced through the rent.

Certain joints are especially liable to dislocation. In many instances this may be explained by their situation or construction. The shoulder, for example which depends for its security mainly on the muscles that surround it, not on the shape of its articular surfaces or on the strength of the ligaments, is dislocated more frequently than all the rest of the joints together. In children, again, dislocation of the elbow is particularly common, owing to the small size and smooth, rounded surface of the coronoid, which does not offer so much resistance as the sharply marked process of adult life. In other instances the tendency is acquired: a shoulder-joint that has once been dislocated is more likely to be dislocated a second time; and if this happens often, the joint becomes so insecure that the bone slips in and out of the socket whenever the arm is raised from the side.

2. *Immediate.*—These are muscular action and external violence.

(1) *Muscular action.*—In some instances, notably the lower jaw and the patella, this acts entirely by itself; in most, however, it is only of secondary importance, fixing the segments of the joint and rendering other articulations rigid, so that force is transmitted unbroken along the limb; and in dislocations by direct violence it plays no part at all. On the other hand, it is almost entirely responsible for what is known as *consecutive displacement*, that is, the alteration in the position of the dislocated bone after it has been driven through the capsule.

(2) *External violence.*—This may be either *direct* or *indirect*. The former is not common, but it occasionally happens that the head of the humerus is driven directly through the capsule of the joint by a blow upon the shoulder; or, when the body is much flexed, the head of the femur forced out from the acetabulum on to the dorsum.

In dislocations by indirect violence the force is applied at some distance from the articulation, either to the same bone, or, as it falls upon the hand, to the other end of the limb. The neck of the bone is fixed and acts as a fulcrum, and the head, which represents the short arm of the lever, is tilted out from its socket and forced against the capsule until it is driven through it. The spasmodic contraction of the muscles and the weight of the part drag it still further aside.

Pathology.—The immediate effects of a dislocation are more extensive than would be expected from the appearance of the part and from the ease with which repair is carried out when the skin is unbroken. Generally speaking the tissues on one side of a limb are strained and rent, those on the other crushed and bruised by the pressure of the displaced bone. Ecchymosis, sometimes making its appearance a long way off, and perhaps days after the injury, is always a prominent feature. The capsule is usually torn at its weakest spot, sometimes it is stripped off the bone, and occasionally it drags away with it portions of the articular margin. The ligaments suffer in the same way, except the stronger ones, such as the iliofemoral band at the hip, and the interosseous one between the tibia and fibula at their lower extremity; these either resist successfully, or only give way after the bones are broken. The muscles are always more or less crushed and bruised; in many instances they are extensively torn, unless, as sometimes happens, they wrench away with them the process of bone to which they are attached. Arteries and veins share the same fate, but though they are not unfrequently compressed and bruised, so that the circulation through the limb is interfered with and even interrupted altogether, the larger ones are rarely torn across in recent dislocations, unless the violence is extreme. Nerves escape even better: they are so tough that they rarely give way, but if they are compressed there may be the most intense pain, and if it is kept up for any length of time permanent loss of power may follow.

The bones are frequently broken: sometimes, as already mentioned, merely a process is torn off; sometimes, as in the case of the fibula, when the ankle is dislocated, the shaft gives way, perhaps at a distance from the seat of injury. Occasionally other structures that lie near are injured too; the trachea, for example, may be seriously compressed in dislocations of the clavicle, and the spinal cord or the medulla may be crushed in displacement of the vertebræ.

As soon as reduction is accomplished these effects begin to pass away; the blood becomes absorbed, the effusion into the synovial sac and the spaces near it disappears, and the lymph thrown out by the injured structures gradually becomes organised. In some instances, where the capsule is very extensively torn, the rent is never thoroughly repaired, and the joint remains weak and untrustworthy. In others an excessive amount of lymph is thrown out; for want of properly regulated passive motion, adhesions form between adjacent parts, and the joint becomes stiff and more or less crippled and painful. The same thing may happen from injury to the neighbouring muscles. Occasionally inflammation sets in—suppurative arthritis very rarely, so long as the skin is unbroken; but rheumatoid arthritis, or gout, or strumous disease, according to the particular diathesis, not uncommonly.

If the dislocation is not reduced the head of the bone and the surrounding structures mutually adapt themselves to each other. The old cavity gradually becomes contracted and shallow; in many cases the outline becomes angular from the pressure of the displaced head resting on one of its borders; the cartilage at the bottom grows thinner and thinner, and either disappears altogether, or is replaced by fibrous tissue which fuses with the shrunken and collapsed remains of the capsule; and, at length, though some semblance of its original character is always preserved, the socket becomes so altered that even if the head of the bone were replaced it could no longer play its proper part. How soon these changes take place depends mainly upon the age of the patient and the presence or absence of that kind of inflammation which so often complicates joint injuries. On the one hand, the glenoid fossa has been found so altered within thirteen weeks of the accident that reduction could not have been effected; on the other, the acetabulum has been shown to be to all intents and purposes intact after as many years.

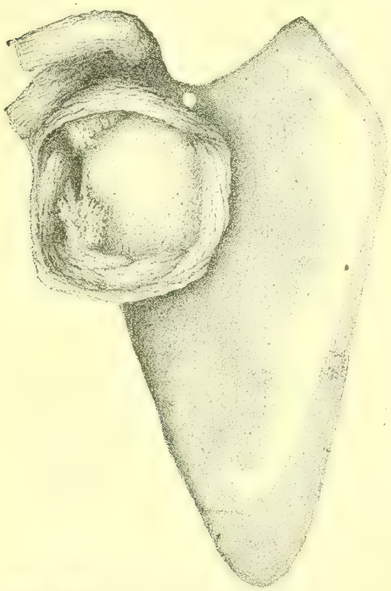
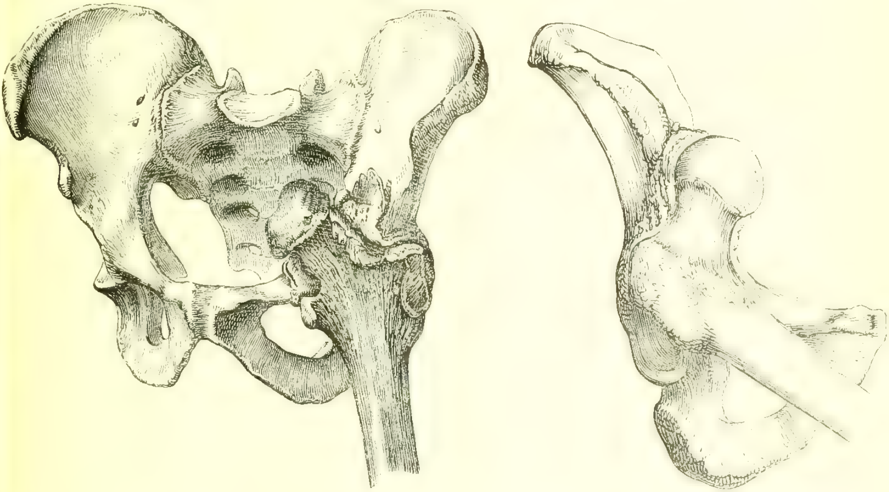


FIG. 188.—Old subcoracoid luxation of humerus. The new cavity is for the most part eburnated; around is a new capsule of fibrous tissue, while some of the old is still left as a fringe on the edge of the glenoid fossa.

The changes in the displaced bone depend chiefly upon the character of the bed upon which it rests and the extent to which the limb is exercised. If the articular surface is embedded in muscles, or lies upon a soft mass of connective tissue, the cartilage slowly becomes fibroid and disappears, the ends of the bones waste away, and lose their characteristic shape, and adhesions form between them and the structures around. Where, on the other hand, it is directly in contact with the periosteum, as in subcoracoid dislocation of the humerus, the surfaces wear each other away and become moulded together in such a fashion that the original outline can hardly be traced. In most instances the cartilage disappears and the articular lamella beneath becomes hard and eburnated, as in rheumatoid arthritis (fig. 188); sometimes it becomes fibrous, and a dense layer of similar material forms on the opposing surface, so that movement is smooth and free. In time, if the part is sufficiently used, a new socket is developed, partly worn out by absorption, partly built up by the deposit around the margin from the irritated periosteum; and the lymph thrown out by the surrounding tissues becomes modelled into a capsule, lined with a membrane like that found in adventitious bursæ, and filled with a similar kind of fluid (figs. 189 and 190). Occasionally this is carried to such an extent that the joint becomes nearly as useful as it was before; but, as a rule, hinge joints do not succeed so well as ball-and-socket ones.



Figs. 189 and 190.—New sockets in old pubic and subspinous dislocations of hip.

All the structures that lie near are more or less affected; the old capsule shrinks and contracts or becomes adherent to the cartilage; the muscles waste from disuse and become fatty; the bone is hollowed out in the interior; and the tissues are matted together by bands of organised lymph. Sometimes the displaced bone is firmly fixed; sometimes it is so movable that it becomes a grave source of inconvenience. Occasionally it causes very serious consequences by pressing upon or becoming adherent to important structures, such as nerves and blood-vessels. In all probability this is the reason why rupture of the axillary artery occurs so frequently in reducing old dislocations of the humerus. The vessel is bound down to the head of the bone by adhesions, so that the strain falls directly upon it as soon as any traction is made upon the limb.

Symptoms and diagnosis.—The only certain sign of a dislocation is the sudden disappearance of the articular end of a bone from its normal situation, or its sudden appearance somewhere else. The account of the accident, though it should always be carefully enquired into, is only of use as confirmation, and the pain depends mainly upon accidental circumstances. In most instances it is severe and long-continued, but when the dislocation has already occurred several times it may be comparatively slight. Only in such cases as when the head of the humerus presses upon the brachial plexus and causes intense neuralgia down the arm, can it be looked upon as a diagnostic sign.

The first thing, therefore, is to compare the injured part with the corresponding joint on the opposite side of the body. Sometimes the alteration in outline is conspicuous at the first glance, as in the sterno-clavicular articulation; or, as in dislocations of the hip, the position of the limb is enough to prove, not only that the head of the bone has been forced out of its socket, but that it has been driven in one definite direction. If inspection fails, there may be some marked alteration in the length of the limb; or local measurements, especially in such joints as the elbow, where the bony prominences are close beneath the skin, may supply the necessary evidence. If the diagnosis is still uncertain, deep pressure may reveal the altered position of the bones; natural prominences may have disappeared, or some depression may be filled up. Finally, before an attempt is made to move the part, valuable information may sometimes be obtained from other evidence of local pressure; the arm, for example, may be œdematous from the head of the humerus resting upon the axillary vein, or the pulse at the wrist may be absent from compression of the artery.

Inspection, measurement, and palpation may prove the existence of a dislocation; manipulation only can determine the particular variety and exclude all other injuries. Owing to the pain it causes, it should always be postponed to the last; and, particularly in the case of the hip and elbow, it is often necessary to administer an anæsthetic; the strength and the size of the muscles in the one, and the amount of swelling in the other, render it a matter of very great difficulty without. Voluntary movements are always restricted; in many instances, as in dislocations of the lower jaw, they are altogether impossible; passive movements are more variable; sometimes, when the soft parts are very extensively torn, they are unnaturally free, especially when the patient is under an anæsthetic; but nearly always they are restricted in at least one direction, either by the locking of the bones or by the tightening up of ligaments that have not given way.

The diagnosis has to be made from severe sprains, fractures in the neighbourhood of a joint, and the separation of epiphyses. The chief features are the absence of crepitus, the character of the deformity, the fact that when it has once been rectified it does not return, and the immobility of the part, both as regards active and passive movement; but not one of these by itself can be regarded as sufficient. Crepitus is absent in many fractures and present in many dislocations, because there is a fracture combined with them; moreover, false crepitus, due to the displaced bone rubbing over tendons or pressing on bursæ filled with extravasated blood, is sometimes very difficult to distinguish from real. Deformity, too, may return at once unless steps are taken to prevent it (as in dislocations of the ankle), and immobility, passive as well as active, is not by any means a sure guide. In each case it is absolutely necessary to weigh the whole of the evidence before coming to a positive decision.

A peculiar condition is occasionally met with in ball-and-socket joints (especially the shoulder), which, though not a dislocation in the strict sense of the term, yet resembles it in many respects. The head of the bone and the socket are both intact, but they are not in apposition. The capsule is stretched; the articular surfaces are separated; there is complete loss of power; the position of the limb is that of a real dislocation, but there is undue mobility. In the case of the humerus there is generally paralysis of the muscles, passing from the trunk to the arm, and the head of the bone can be replaced at once by raising the elbow; in other joints it seems to be the result of chronic distension of the capsule: the fluid insinuates itself between the articular surfaces, and the fibres become softened and stretched until they can no longer hold the bones in position. It cannot be called a dislocation, because the head of the bone still lies within the capsule; but neither can it be compared with those cases in which, as a result of rheumatoid arthritis or strumous inflammation, the cartilages are eroded, the bones exposed, and the capsule completely destroyed.

Treatment.—Dislocations should in all cases be reduced as soon as possible. The obstacles are of two kinds. One is mechanical; the head of the bone, for example, no longer corresponds to the rent in the capsule; or it is caught by some ligament or tendon, or locked against some other bone. The other is the contraction of neighbouring muscles. Immediately after the accident they are relaxed and offer but slight resistance. In a short time they begin to contract and drag the dislocated bone farther and farther away. Soon they become absolutely rigid, and at length they undergo a kind of fibroid degeneration; a great deal of their extensibility is lost, and they tear sooner than stretch. In recent dislocations this source of difficulty disappears entirely under an anæsthetic; in old ones it is added to the rest.

There are two methods of effecting reduction, manipulation and extension. In the former, which is almost always used for ball-and-socket joints, the muscles are relaxed, either by placing the patient under an anæsthetic or by moving the limb in suitable directions; the head of the bone is disentangled from the structures that hold it, and brought back along the route it has taken until it is opposite the rent in the capsule; then it is either lifted over the margin of the socket or tilted in by using the untorn portion of the capsule as a fulcrum and making the limb the long arm of the lever. In the latter the muscles are stretched until they either yield or tear, all obstacles are broken down or pushed aside by main strength, until the head of the bone is free and can be forced into position again.

Extension may be made with, or without, the aid of appliances, but in recent dislocations it rarely happens that more than a jack-towel is required. The trunk or the proximal segment of the limb must be securely held for counter-extension. If it is the humerus, the knee or the foot may be placed in the axilla; or a well-padded towel or leather belt passed round the arm and fixed to a hook or staple in the opposite wall; but it is of great advantage to have an assistant who, besides helping to fix the scapula, can manipulate and disengage the head of the bone at the same time. In the case of the femur, if manipulation has failed and extension is being tried, this is always one person's duty.

In recent dislocations, simple manual extension is generally sufficient, especially if the muscles are relaxed by an anæsthetic; and the limb may be grasped at the most convenient situation—the wrist, for example, in dislocations of the humerus. If more than this is required, a jack-towel may be made into a clove-hitch and fastened round the limb; but the skin must be carefully protected by means of a wet bandage, and extension must be made from the lower end of the displaced bone without an intervening joint. If the limb is grasped with the hands, and the loop of the towel is passed over the shoulder of the operator, so that he can bring into play the muscles of his back, sufficient power may be obtained to overcome the resistance of any joint but the hip.

If the dislocation has already lasted some length of time, so that the muscles have degenerated and the lymph has become organised, mechanical contrivances, such as multiplying pulleys, may be required. The adhesions are first broken down by manipulation and rotation; then the limb is carefully bandaged with a wet roller to prevent slipping and to protect the skin; counter-extension arranged so as to avoid bruising, and to leave the part accessible; and the leather collar to which the cord of the pulley is attached buckled round the lower end of the displaced bone. An anæsthetic is indispensable. The other end of the pulleys is then made secure, and the rope tightened very gradually and quietly, avoiding anything like a sudden jerk, and making extension in the axis of the limb. The amount of force must be regulated by the case: the operator must keep his hands upon the head of the bone, assisting it as far as he can in the right direction by manipulation and rotation, and watching carefully the progress that it makes and the tension upon the skin. Very serious injuries have before now been inflicted in cases of this kind, and sometimes important structures have been torn across, even when the amount of force used was quite insignificant, probably owing to the tissues being bound together by adhesions, or softened and weakened by degeneration.

When pulleys are not available, a very efficient substitute may be manufactured out of a simple piece of rope doubled once or twice upon itself. By placing a ruler in the middle and twisting it up, any required degree of traction may be obtained, slowly and evenly. No estimate, it is true, can be formed as to the actual amount of force employed; but it is more than doubtful whether such is really of any use; each case must be decided on its own merits.

As soon as the head of the bone is brought down, an attempt must be made to carry it in the direction of the socket. If it is the humerus, the arm is drawn across the chest, making use of the surgical neck as a fulcrum, or it is abducted as far as it can go; or, while the arm is fixed, the trunk is swayed slowly from side to side. If the femur, a broad band is looped round the thigh to lift the bone upwards, or outwards, according to the direction of the displacement. In the case of the lower jaw again, firm pressure is made in a backward direction upon the coronoid processes. In short, in each dislocation the method of manipulation, when once the head of the bone has been forced down, must be guided by the structure of the joint, the direction of the displacement, and the character of the obstacles that stand in the way.

After a certain period, varying for each joint, reduction becomes impossible. Even if it could be effected, it is more than doubtful whether the use of the part would in any way be improved, owing to the extensive changes that take place about the articular ends. In such cases all that can be done is to break down the adhesions as thoroughly as possible, and by means of massage, friction, galvanism, and passive motion, improve the nutrition and freedom of the parts as far as may be.

In recent dislocations, when the patient is not under the influence of an anæsthetic, as soon as the head of the bone is brought opposite to the rent, it is pulled into the socket, with a sudden, sometimes almost audible, snap. In old ones however, or when the muscles are relaxed, and in paralysed limbs, replacement is gradual, and may even be imperceptible, except for the restoration of the full range of movement, and a certain amount of alteration in shape.

The treatment of a dislocation, after it has been reduced, does not differ from that of a severe sprain : the joint must be secured, so that there is no danger of a recurrence ; kept perfectly quiet, and either bandaged or covered with some evaporating lotion, or with Leiter's coils. Inflammation rarely follows, probably because the capsule is extensively torn, and intra-articular tension is impossible ; but, for all that, every precaution should be taken to prevent its occurrence.

The length of time the joint should be kept at rest depends more upon its kind and construction than on the injury that has been inflicted. There are dangers on either side. On the one hand, if the part is kept at rest too long, adhesions may form between contiguous surfaces, or the capsule become hard and rigid. On the other, if movement is allowed too soon, there is always the possibility of the rent in the capsule never being repaired, or, worse still, of inflammation setting in. The question turns mainly upon the kind of movement. Passive motion is perfectly safe, and, if carried out under proper supervision, may be commenced in the first week ; it stretches out the folds of the capsule, prevents the muscles and ligaments becoming shortened, and checks the formation of adhesions, without endangering the prospect of union or giving the faintest reason for inflammation. Active movement, on the other hand, because it cannot be so well controlled, must be postponed until passive motion is free from pain, and until all risk of recurrence has disappeared. In the hip and elbow, where the security of the joint is dependent upon the shape of the articular surfaces, it may be allowed with certain precautions after the first few days ; in the lower jaw, however, and still more in the shoulder, free movement without restriction cannot be permitted for at least a month, and certain particular actions are especially to be forbidden. A variable amount of stiffness is always present after a dislocation, and the muscles atrophy to some degree, particularly the extensors ; but this soon disappears. Massage and galvanism are of very great service if it shows the least tendency to persist. It must not, however, be forgotten that a rapidly progressive form of osteo-arthritis is not an uncommon complication of joint injuries, especially in those who are gouty or rheumatic, and that muscular wasting is one of its earliest signs.

Compound dislocations, in which, in addition to the displacement of the bones, the skin is torn or cut and the synovial cavity of the joint exposed, are exceedingly serious, even when they are not complicated by the addition of fractures or other injuries. The danger is the occurrence of suppurative arthritis. If this breaks out, the joint rarely recovers without some degree of ankylosis ; often the cavity is entirely obliterated and the articular surfaces are united together by dense fibrous tissue or by bone. Even this result, however, cannot always be obtained. If suppuration once develops it is impossible to say when or where it will stop, and the risk, as regards life as well as limb, increases with the size and complexity of the synovial membrane. Abscesses may form in the tissues near ; the pus may spread in the tendon-sheaths, or in the loose tissue around them half-way along a limb ; erysipelas, cellulitis, or pyæmia may break out at any moment ; the bones may be eaten away on the surface or even perish completely ; and at length, if the patient does not succumb from septic absorption, and if the limb does recover, it may be so stiff and œdematous as to be absolutely useless, or there may be such an amount of discharge that it has to be removed for fear of hectic or amyloid disease.

The treatment of compound dislocations must be guided by the same considerations as that of compound fractures into joints. The choice lies between an attempt to save the part, excision or amputation ; and the decision must be determined in each case partly by the age and constitution of the patient, partly by the situation of the joint and the extent of the injury. The first question is whether it is possible to save the limb without running too great a risk, and whether, supposing this is successful, the limb is likely to be of any use afterwards. In compound dislocations of the knee-joint there is rarely any hope unless the tissues at the back are quite intact ; but in other joints, especially in those of the upper extremity, it can often be managed, if only the vessels are unhurt and the skin not too much torn or stripped up. Nerves do not seem to be of so much consequence in this matter ; they are so tough that they rarely give way, and even if they do they may often be joined again by means of sutures.

Whether the joint should be excised or not depends upon the condition of the ends of the bones. If they are comminuted, and the soft parts not seriously injured, this may be done with great success, especially in the case of the shoulder and elbow ; but it must always be remembered that primary excision is not to be compared, either in its course or its results, with the same operation when performed for disease. The smaller joints, those in the fingers, for example, sometimes succeed very well.

If it is decided to try and save the joint, the protruding bone and the surrounding skin must first be thoroughly cleansed with some antiseptic ; fragments that are too much bruised or ground-in with dirt to live, removed ; and reduction effected as soon as possible. Generally there is no difficulty in this, owing to the extent of the laceration ; but sometimes the head of the bone is so tightly embraced by the skin that the opening has to be carefully enlarged.

Then the cavity of the joint must be washed out again and again, and laid freely open, so that there may be thorough drainage. The most efficient method of carrying this out is either to immerse the part bodily for an hour each day in a bath of corrosive sublimate or carbolic, with the wounds widely open, or to use continuous irrigation with water as already described in speaking of penetrating wounds. Merely passing a drainage-tube through the synovial cavity is of little or no service, and small incisions are worse than useless ; the discharge must be thoroughly removed. The limb may then be placed upon a splint, well bandaged, raised and kept at perfect rest in the position that will ultimately be most useful. An ice-bag laid upon the joint, or over the course of the main artery of the limb, is of some assistance in controlling the amount of blood flowing to the part ; but care should be taken that the application is really continuous.

The further course must be guided by the temperature and the degree of inflammation that ensues. Careful watch must be kept that the discharge cannot collect anywhere. If suppuration sets in the freest possible incisions may still be tried; but unless it is checked at once the cartilages necrose, the synovial lining is destroyed, the cavity is filled with granulation-tissue, and abscesses form everywhere in the cellular tissue around. At first the constitutional disturbance is exceedingly severe, especially in the case of the larger joints; gradually, as the tissues gain the upper hand, the fever begins to drop of a morning, and if no further complication sets in assumes the hectic type; and then again it may become a question whether the patient's strength is sufficient, or whether it may not be advisable to perform some secondary operation, excision or even amputation.

Fractures and dislocations are not unfrequently combined. In many instances, as in the ankle, one can scarcely occur without the other, and the injury may be looked upon as one. Occasionally, however, a fracture is present as a complication: the humerus, for example, is dislocated, and the surgical neck broken by the same force. When this occurs it has been recommended to allow the fracture to unite before attempting to reduce the dislocation, but if it is possible the head of the bone should be replaced at once. The patient should be placed under an anæsthetic, the fracture securely fixed between splints, and the displaced bone manipulated as far as it can be in the right direction. Extension may be tried if the fracture is at some distance, at the other end of a long bone, or even in the middle; but if the injury is near the joint it is rarely practicable. If this fails the only course left is either to lay the part open, and convert the fracture into a compound one communicating with a synovial cavity, or by passive motion to encourage as far as possible the formation of a false joint.

Dislocations of the Lower Jaw

Dislocation of the lower jaw may be unilateral or bilateral, but it can only take place in one direction, forwards. As the mouth opens the condyle and the fibro-cartilage are brought forward together upon the eminentia articularis; the external lateral ligament, which normally runs downwards and backwards, becomes nearly vertical; the internal and posterior are stretched, and the coronoid process is lowered into a slanting direction. If at this moment the external pterygoid contracts, or if a slight blow is delivered in a downward direction upon the incisor teeth, the condyle slips forward on to the front of the eminence and is carried up into the temporal fossa by the combined action of the temporal, masseter, and internal pterygoid. The capsule appears to stretch rather than tear, though the tension on some of it must be very severe, and sometimes the temporal muscle is a little torn.

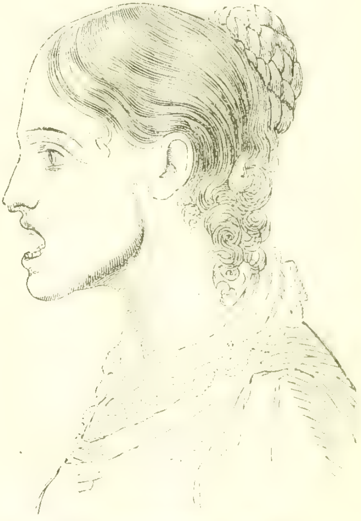


Fig. 191.—Dislocation of lower jaw.

Causes.—Dislocation may be produced either by muscular action alone, or by indirect violence, but neither of these is capable of effecting it unless the mouth is widely open. If it is the former of the two, the condyle is pulled forwards; if the latter, the bone is converted into a lever, of which the coronoid process, fixed by the temporal muscle, is the fulcrum; the force is applied to the symphysis, and the condyle is driven forwards. It often happens from yawning or shouting, but it may be caused by blows with the fist; by forcing into the mouth anything that is too large; and even by such operations as the extraction of teeth and taking wax casts of the alveolar arch. It is rare in children, because in them the eminence hardly exists, and because, owing to the shape of the jaw, the temporal muscle does not obtain such leverage; and it appears to be more common in women than in men.

If both sides are dislocated the symptoms are very characteristic. The patient supports the lower jaw with his hand to prevent further movement, the mouth is widely open, the chin protrudes, the saliva dribbles away, and speech is exceedingly difficult. Labial consonants cannot be pronounced at all. In place of the natural projection in front of the ear, caused by the condyle, there is a depression; in front of this, making it more distinct, the skin is raised, partly by the bone, partly by the irregular contraction of the fibres of the masseter; and movement, except to a very slight extent in a downward direction, is out of the question. The first time the dislocation happens the pain is very severe, but in old recurring cases it may be so slight as not to cause any complaint. If the displacement is only on one side, the lower jaw appears to be pushed towards the other one; the face is much less distorted; and though the general symptoms are the same, they are often so slight as to lie in some danger of being overlooked.

Subluxation or partial dislocation forwards is very common in young people, and sometimes gives rise to much inconvenience, as it is liable to occur whenever the mouth is widely open. The jaw is caught, as it were, and held until the condyle is forced back by pressing the chin upwards; formal reduction is rarely necessary.

Treatment.—The patient should be seated with the mouth wide open; the head is thrown back and supported from behind, the thumbs (protected with a handkerchief or some lint so that they may not be bitten), are placed on the molar teeth as far back as possible, the fingers brought round under the chin, and pressure made downwards and backwards with the one, while the symphysis is raised by means of the others. By this the lower jaw is converted into a lever of the first order, the thumbs form the fulcrum, and ought therefore to be placed as far back as they can; the downward pressure helps to disengage the condyles, and as soon as they become free the muscles pull the jaw back with a sudden snap. Generally the two sides slip back together; but in old dislocations, or if there is any difficulty, an attempt may be made upon one first, only care must be taken not to displace it again while the other is being reduced. Sometimes reduction is impeded by the coronoid process becoming entangled in the fibres of the temporal muscle; and in one case, at least, it is certain that it caught against the malar process; but this can generally be obviated by depressing the chin somewhat farther before trying to raise it.

If this plan fails other measures must be adopted to obtain more power. Wedges of cork or wood may be placed between the molar teeth and the chin drawn up by main force; in one case, four months old, Pollock made use of a strap-tourniquet, which was passed round the head, under the chin, and slowly screwed up. The angle may be depressed by resting one end of a flat piece of wood about a foot long upon the molars, and pulling the other upwards, the teeth of the upper jaw serving as a fulcrum; or a stout pair of forceps may be introduced as far back as possible, and the blades separated from each other. Direct pressure backwards upon the coronoid processes from the inside of the mouth is sometimes successful, even in dislocations of long standing.

A four-tailed bandage must be worn for a week or ten days after, and the patient should be warned that yawning or opening the mouth wide for any other purpose is exceedingly likely to reproduce the displacement for months to come.

If the dislocation is not reduced, the amount of movement gradually increases until the patient is able to close the lips and to open the mouth fairly wide, but the teeth can never be brought properly into apposition with each other.

Dislocation of the Clavicle

The sternal end of the clavicle is rarely displaced, although the articular surfaces are very little adapted to each other. The shoulder is so freely movable that no severe strain falls upon the joint, unless the force is applied to the clavicle directly, and the inter-articular fibro-cartilage, and the ligaments that hold the bones together, are so strong and secured so well by the muscles, that the clavicle, as a rule, gives way before the joint. The natural movements take place either on a vertical axis between the fibro-cartilage and the sternum, or on an antero-posterior one between the same structure and the clavicle. When they are carried too far the capsule gives way, and the articular end of the bone is forced through the rent, either forwards, backwards, or upwards.

In spite of the backward direction of the articular facet on the sternum, and the hook-like projection on the posterior margin of the clavicle, dislocation forwards is the most common of these. The sternal end of the bone is carried on to the front of the manubrium, and stands out beneath the skin; the clavicular portion of the sterno-mastoid is tense and rigid; the head is inclined downwards and forwards; the shoulder is approximated to the middle line, and all the movements of the arm, but particularly any attempt to bring the shoulders forward, are attended by severe pain.

Dislocation backwards is equally plain, only in this case there is a well-marked depression by the side of the manubrium instead of an elevation, and the shoulder is brought forwards, as well as towards the middle line. Sometimes the head of the bone presses upon the trachea or œsophagus, causing extreme dyspnœa or dysphagia, and in one instance coma is said to have ensued from pressure upon the innominate vein.

Dislocation upwards is more rare, and might almost be regarded as a variety of the former, as the articular end is always carried backwards as well to some extent, sometimes sufficiently far to press upon the trachea. It lies behind the sternal portion of the sterno-mastoid, between it and the sterno-hyoid, filling up the episternal notch; the shoulder is carried far inwards towards the middle line, and the neck is bent, as much to relieve the respiration as to relax the muscles.

In all of these the rent in the capsule is very extensive; the rhomboid ligament either gives way, or the cartilage of the first rib is torn; the fibro-cartilage in the interior of the joint is separated from the clavicle, or more often from the sternum; and the muscles, especially the sterno-mastoid, are put upon the stretch, and sometimes torn.

Causes.—Dislocation of the sternal end of the clavicle may be produced either by direct or indirect violence. In the former case, the force is applied to the inner end of the bone, as when a cart-wheel passes over the chest; the displacement must be either backwards, or backwards and upwards; and often the surrounding structures, such as the ribs and sternum, are crushed as well. In the latter, where the force acts either on the shoulder, or on the outer end of the bone, the displacement may take any direction, except downwards. A blow, for example, on the front of the shoulder, forcing it backwards, causes the clavicle to rotate on its centre, and throws the strain upon the anterior sterno-clavicular ligament, the joint opening out in front. If the force continues, the head of the bone is displaced forwards until the ligaments give way, and it is carried on to the front of the manubrium. In a similar manner, a force applied from behind, or violent traction on the arm from the front, causes the clavicle to rotate in the opposite direction, and tends to produce dislocation backwards. But while the cause of these dislocations is fairly clear, the mechanism by which they are produced is not so easily understood. Owing to the convexity forwards of the inner part of the clavicle, it is impossible for the first rib to act as the fulcrum of a lever: and these dislocations cannot be produced in the dead subject, without previous division of some of the ligaments. They cannot therefore be the result merely of traction or pressure applied to the outer end of the bone, regardless of everything else. The contraction of the surrounding muscles is of some assistance, and rigidity of the thorax is very likely essential (they have been produced on several occasions by pressure in crowds, and by wrestling), but probably the most important element is the position of the vertebral column at the moment of the receipt of the injury. In some cases of extreme spinal curvature, gradual displacement has resulted from this alone without the occurrence of any accident.

Partial dislocation, without tearing of the capsule, is common among young people of weak muscular development; and is often noticed for the first time after some sudden strain or unusual muscular exertion. The bone projects on the front of the articulation forwards, or forwards and upwards, but slips back again into its position as soon as the weight of the limb is taken off. The chief inconvenience is the weakness of the arm and the sense of insecurity; sometimes this is so marked that the use of the limb is seriously impaired.

Treatment.—The method of reduction is the same for all of these. The patient is seated upon a low stool, with his back to the operator. The latter places his knee against the spine, between the scapulæ, and grasping the shoulders, draws them backwards, the patient's elbows being kept in front of the median-lateral line. Generally the head of the bone slips in either at once, or with a little manipulation; if it resists, a stout pad may be placed in the axilla, and the elbow be drawn into the side, so as to lever it out. The difficulty is after reduction has been effected: there is nothing to retain the bone in its proper position; the articular surfaces are almost flat; all the ligaments are torn; the whole weight of the arm rests upon it; and every movement, even that of respiration, affects it.

In the backward or the backward and upward dislocation, Velpeau's plan is the best. The bone is held in position; the axilla carefully padded so as to square up as far as possible the conical shape of the thorax; the elbow brought forward to the middle line, and well raised by strips of plaster, and the hand fastened against the opposite shoulder. In the forward dislocation, which in this respect is the worst of the three, a double figure-of-eight succeeds better. A stout pad or a thickly covered splint is placed between the shoulders, and the bandage is carried around them alternately, to draw them back as far as possible. Astley Cooper recommended that well-padded straps should be carried round the axillæ, and fastened back by leather bands to a splint, fitting against the spine, and well secured round the body. In any case it is important to fix the scapulæ against the ribs; and where there is serious concern about the deformity, the best plan is to keep the patient in bed, in the supine position as long as he can be induced to stand it. If the dislocation is forwards, a well-fitting pad, over the projection, firmly strapped down, is often of great assistance.

Whichever method is adopted, the arm must be kept rigidly fixed for at least three weeks; if plaster is not used, the bandages must be secured with starch or dextrin, as Velpeau recommends; after that the confinement may be relaxed to some extent, but no movement should be allowed for at least as long again; and some protection, either a pad or a properly made truss, must be worn until it is certain that repair is perfect. In some instances it is impossible to retain the bone in position. If the displacement is forwards this is not so serious, though the deformity is very unsightly, as a new joint soon forms, and the arm regains a great deal of its power and freedom of movement; but when the bone lies wedged between the posterior surface of the sternum and the trachea, and either cannot be dislodged, or cannot be prevented from slipping back, it has been found necessary to divide the shaft and remove the inner extremity.

Dislocation of the Scapula

The acromion may be dislocated from the clavicle in two directions, upwards or downwards. The former is exceedingly rare; the latter, in spite of the shape of the articular surfaces, is not so common as might be expected, owing to the strength of the conoid and trapezoid ligaments, which form the main bond of union between the bones.

The cause is nearly always a fall or a blow upon the shoulder delivered from behind and above, so as to drive the point of the acromion downwards and forwards. Partial displacement, however, is met with now and then in rapidly growing girls, merely from carrying heavy weights upon the arm. Probably in these cases the fibres of the capsule do not give way completely.

Complete dislocation can hardly be mistaken. The head is inclined to the injured side; the margin of the trapezius stands out distinctly; the outer end of the clavicle is raised and forms a great projection upon the acromion, and the scapula is depressed and rotated. There is tenderness on pressure over the coracoid, the movements of the arm are painful and very limited, and raising it even to the level of the shoulder is impossible.

Like the preceding, this dislocation is very easy to reduce and very difficult to keep in position: all that is necessary is to draw the shoulder back, press the clavicle down, and the scapula slips out from underneath at once; but as soon as the pressure is relaxed the displacement appears again. Very often the bones cannot be made secure, and then a new joint is gradually developed in the upper surface of the acromion, and, though the projection is very unsightly, the arm regains nearly the whole of its power, except for overhand movements.

The most successful method of treating this dislocation is by means of Velpeau's dextrin bandage, only substituting Holland plaster, which never stretches. Great care must be taken to prevent sloughing of the skin. If this fails a pad may be placed over the acromial end of the clavicle and strapped firmly down by means of a broad webbing band carried over it and under the point of the elbow. In such a case the axilla must be well padded and the scapula fixed as far as possible against the wall of the thorax. Where deformity is the first consideration, the patient must be kept lying flat on the back in bed for a week or ten days: the scapula is fixed perfectly; the weight of the limb is taken off; the trapezius is relaxed; and the clavicle can easily be prevented from riding up.

Dislocations of the Humerus

The shoulder is dislocated more frequently than all the other joints in the body together. This is due to its anatomical construction: its security is dependent almost entirely on the muscles and tendons that surround it; the glenoid fossa is so flat and shallow that it can afford no protection for the head; the capsule, with the exception of one part, is exceedingly loose and weak; the movements are unusually free in all directions; and the length of the arm gives such enormous leverage that when the head of the bone is driven against the capsule it tears it with the greatest ease.

The cause is nearly always indirect violence—a fall upon the elbow or the outstretched hand; occasionally direct—a blow, for instance, upon the back of the shoulder while the arm is abducted; in a few rare instances, muscular action by itself, without outside assistance.

1. *Dislocation by indirect violence.*—This is always the result of abduction. As the arm is lifted away from the side, the great tuberosity comes into contact with the upper margin of the glenoid fossa and the surgical neck with the acromio-clavicular arch; if the scapula is fixed and the force continues, the head projects against the under and inner part of the capsule until it tears it across, leaving the strong upper part tensely stretched by the strain that falls upon it; then as soon as the force is expended the weight of the arm and the contraction of the muscles carry the head of the bone along the margin of the glenoid fossa, until it either reaches the base of the coracoid or is buried in the substance of the subscapularis. In the first part of the act, the great tuberosity or the surgical neck forms the fulcrum of the lever; as soon as the dislocation is effected, the upper untorn portion of the capsule (the coraco-humeral ligament included) becomes the fixed point, and the head of the bone glides upwards as the hand sinks. In a few instances, owing to the head of the bone in some way being caught immediately after bursting through the capsule, this consecutive displacement does not take place, and the arm remains in the position of extreme abduction (*luxatio erecta*).

Complete abduction, however, is not absolutely necessary. If the arm is held only a moderate distance from the side, a blow upon the inner condyle of the humerus, or an outward pull upon the arm, may dislocate the head of the bone. One part of the humerus is fixed by the coraco-humeral ligament; another, a little lower down, by the muscles, especially the deltoid; some point between the two serves as a fulcrum, and the force applied to the inner side of the elbow levers the head of the humerus out.

2. *In dislocations by muscular action*, which are much more rare, the mechanism is somewhat the same, only the force in this case is the momentum of the arm. When it is moderately abducted, the upper part of the shaft of the humerus is fixed between the abductors (the deltoid) and the adductors (the pectoralis major and the latissimus dorsi), so that a kind of fulcrum forms, upon which the arm swings. If at the moment this takes place the lower part of the arm is moving vigorously in the direction of abduction, the head of the bone is driven to the opposite side, against the front and inner part of the capsule, and may be forced through into the subscapular fossa.

3. *Dislocation from direct violence* is not very uncommon. It can easily be produced by a blow upon the shoulder when the arm is abducted and held in a horizontal position. The scapula yields a little, the head is driven against a weak part of the capsule, and the bone is dislocated either backwards or forwards, according to the position of the arm and the direction of the blow.

Varieties

With the exception of some of those that are produced by direct violence, all dislocations of the humerus are primarily downwards into the axilla, but it is only in the rare cases of what is known as *luxatio erecta* that the bone retains that position. Nearly always it is carried, partly by the weight of the limb, partly by the contraction of the muscles, either in a forward or backward direction, upwards along the margin of the glenoid fossa.

There are four well-marked varieties of this consecutive displacement: three forwards—subglenoid, subcoracoid, and subclavicular; and one backwards—subspinous. Besides these, minor varieties have been described—subacromial, for instance, and supra-coracoid; but they are very uncommon, and the latter at least cannot take place without the presence of fracture as well.

1. *Subcoracoid dislocation.*—This is by far the most common; indeed, it is the only dislocation that is usually met with, the others are all exceptional. The rent in the capsule lies on the inner and lower border of the glenoid fossa, often commencing at the opening for the bursa; the head of the humerus is pushed between the bone and the subscapularis muscle up to the root of the coracoid, until the anatomical neck rests upon the anterior margin of the glenoid cavity; the muscle is bruised and stripped up from its attachment, the upper and back part of the capsule is strained across the glenoid cavity, the tendon of the biceps is lifted out of the groove as far as the capsule will allow it, and the external rotators attached to the great tuberosity are stretched or torn. If, as sometimes happens, they give way completely or wrench the tuberosity away from the shaft, the bone is drawn more towards the middle line and is less rotated. Sometimes the axillary vessels and the brachial plexus are compressed, but this is not so common or so well marked as in the subglenoid form.

2. *Subglenoid dislocation.*—In this, which is the next most frequent, the head of the bone either escapes below the subscapularis, between it and the teres muscles, or is driven through its substance and pulled up until it

rests upon it opposite the lower margin of the glenoid fossa. The rent in the capsule may be the same as in the subcoracoid variety, or the fibres may be torn away from the under and inner part of the humerus, but the difference does not appear to be material. The external rotators and the other muscles suffer to much the same extent, but the vessels and nerves are more likely to be compressed.

3. *Subclavicular dislocation.*—This is the rarest of the four ordinary forms: in it the head of the bone is carried under the pectoral muscles to the inner side of the coracoid process, so that it projects underneath the skin and can no longer be felt in the axilla. It can only be produced by extreme violence, rupturing the external rotators, or tearing the tuberosity away from the shaft; and the amount of damage inflicted on the surrounding structures is proportionately great.

4. *Subspinous dislocation.*—Under this may be included all the forms of backward displacement in which the head of the bone rests upon the dorsal surface of the scapula beneath the infra-spinatus. The rent in the capsule must involve the lower part, but probably, in the majority of instances, it extends nearly round the whole, the upper part only being left strained across the glenoid cavity. The subscapularis may be merely stretched, or it may be torn away from the humerus.

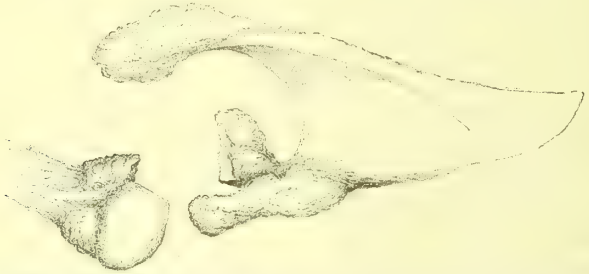


Fig. 192.—Old dislocation of humerus seen from above, showing the way in which the head of the bone and the glenoid edge mutually wear each other away and simulate a partial dislocation.

5. *In the supracoracoid* variety the head of the bone is driven upwards between the coracoid and acromion, fracturing one or other until it rests upon the coraco-acromial ligament and projects through the substance of the deltoid. Only three cases are on record.

Partial dislocations have often been described, but probably, in most instances, they have really been either old unreduced complete ones or the result of chronic rheumatoid arthritis. In the former case, when the head of the bone has been resting for many years on the front margin of the glenoid cavity, it gradually wears it away until it seems as if it were lying partly in the fossa itself, partly on the bone in front of it; in the latter, when the biceps tendon has been absorbed or torn across, the head of the bone is pulled upwards and forwards under the acromio-clavicular arch, and forms there a new socket for itself, with a capsule partly adapted from the old one, partly formed afresh (fig. 229). Genuine cases, however, are occasionally met with; in one under my care, the patient, a tall, overgrown girl of seventeen, was quite unable to place her hand at the back of her head, as, owing to the feeble development of the short muscles, the bone always slipped forward on to the anterior margin of the glenoid fossa, stretching the capsule more and more each time. In other cases, the same result is stated to have been due to the unusual development of the bursa under the subscapularis, and in one instance it was proved by dissection that the capsule had been torn in a way that would allow the head to be partially displaced.

Recurrent Dislocations.—A similar condition of things is sometimes met with after the reduction of an ordinary dislocation : the arm, when an attempt is made to use it, feels too insecure ; if it is raised in the least, the head of the bone slips forwards, and though it generally falls back again into the fossa as soon as it is lowered, sometimes it is caught and requires to be released by manipulation. This is probably caused by loss of power over the short external rotators, which are often damaged or torn in dislocations ; but it may be due to part of the lip of the glenoid cavity having been pulled off by the capsule.

Symptoms.—The appearance presented by a patient with a dislocated shoulder is very characteristic : the head is bent towards the affected side ; the forearm is supported by the other hand ; the elbow is flexed owing to the tension on the biceps, and the shoulder has completely lost its rounded shape ; the point of the acromion stands out beneath the skin ; instead of the normal curve, the line falls almost vertically ; the infra-clavicular fossa is obliterated ; and sometimes the head of the bone projects through the substance of the muscles. The arm is abducted from the side, especially in the subglenoid variety ; in the subcoracoid it may still almost touch, in spite of the convexity of the thorax ; its axis does not run in the normal direction towards the glenoid fossa, but too much inwards ; the elbow, except in the subspinous form, has an inclination backwards, though it does not pass the mid-lateral line of he body, and there is a general look of helplessness about the part. Someimes the arm is swollen from pressure upon the axillary vein ; or the radial pulse cannot be felt ; or again here is intense pain down some of the branches of the brachial plexus.

If, in order to compare the wo sides together more accuately, measurements are taken, he results vary according to he kind of dislocation : in the ubglenoid, owing to the head f the bone lying below its normal level, there is lengthening with marked abduction (mainly due to the coraco-humeral band, but partly perhaps to the muscles); in the subcoracoid the bduction is less and there is o certain alteration in length ; nd in the subclavicular, in which the head of the bone is arried far inwards, the arm points outwards and is greatly shortened. One measurement, however, that is always increased is the vertical circumference f the shoulder, taken round the acromion and the axilla.

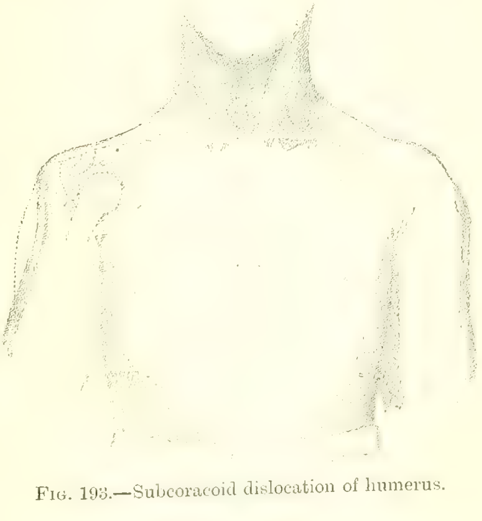


Fig. 193.—Subcoracoid dislocation of humerus.

These results are next to be confirmed by palpation. Under the acromion there is a great depression ; the finger cannot be made to touch the glenoid fossa, owing to the deltoid and the external rotator muscles that cover it, but it seems to sink right in. In the subclavicular form the head of the humerus projects in such a way as to strike the eye at once ; in the subcoracoid it is not so prominent as this, but it always obliterates the natural hollow beneath the clavicle, and in addition can easily be felt by pressing the fingers upwards into the axilla. In the subglenoid this is plainer still: the head of the bone lies lower down ; there is a hollow between it and the coracoid ; and the anterior fold of the axilla is less prominent, owing to the drawing downwards of the pectoralis major. I have only seen two examples of dislocation backwards, but in neither was there any difficulty in making out the exact position of the head.

Finally, any doubt may be set at rest at once by manipulation. Voluntary movement is almost out of the question ; passive movement, though more free, is very painful, and definitely limited. The head of the bone rotates easily in its new situation, though not so freely as when in the glenoid fossa ; abduction to a certain extent is possible still ; but adduction, so as to make the elbow touch the side, especially when the fingers are laid upon the opposite shoulder, is absolutely impossible in all forms of dislocation—the shape of the thorax is such that it cannot be done. This and the vertical measurement round the axilla are almost conclusive.

The diagnosis of dislocation has to be made from :

1. Fracture of the neck of the scapula, in which the glenoid fossa and the coracoid process are separated from the rest of the bone, carrying the arm with them.
2. Fracture of the anatomical neck of the humerus.
3. Fracture of the surgical neck.
4. Separation of the great tuberosity, in which the head of the bone is always dragged forwards by the other muscles, until it rests upon the anterior margin of the glenoid cavity, but within the capsule.
5. Paralysis of the muscles passing from the trunk to the arm, with consequent dropping of the head of the bone, until a great hollow makes its appearance beneath the acromion. This may occur in adults, but is more common in new-born infants, from the pressure of forceps in delivery.

In all of these however, instead of rigidity and immobility, passive motion is unduly free, and the elbow can be made to touch the side with ease ; indeed, it generally is already in contact with it. This is especially true of separation of the great tuberosity, where the difficulty is often a very real one. In all the other fractures crepitus can easily be made out, unless they are either impacted or already in part united.

Treatment.—Immediately after the accident, or in a moderately recent case, when the muscles are relaxed by an anæsthetic, the only difficulty is the mechanical one. The head, for example, no longer corresponds to the rent in the capsule, or it is fixed by the tension of some of the ligaments. After a few hours, however, others are added : the muscles contract and become rigid ; later still they undergo fibroid degeneration ; adhesions form between surrounding structures ; the lymph that has been thrown out becomes organised ; the rent in the capsule is repaired, and sometimes even the glenoid fossa is filled in.

Reduction is effected partly by the aid of the coraco-humeral band, which now runs downwards and inwards from the base of the coracoid to the tuberosities, partly by the tension of the short external rotator muscles and the posterior portion of the capsule, which are tightly strained across the glenoid fossa. The first thing is to fix the scapula, which may be done by an assistant standing behind and pressing it down upon the thorax, while his fingers

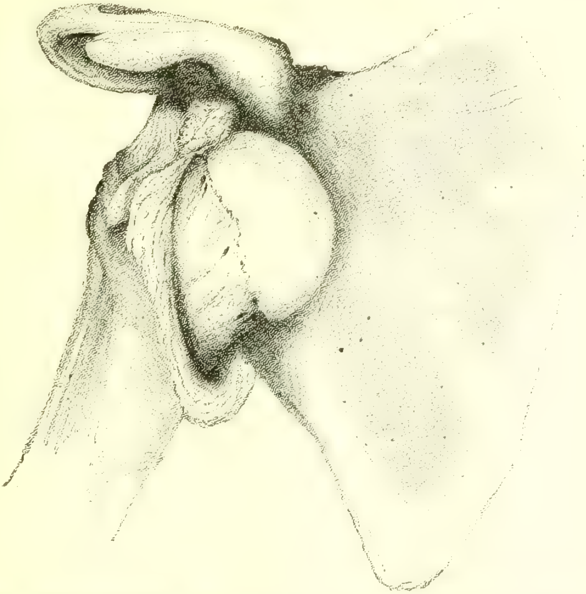


FIG. 194.—Subcoracoid dislocation, with the capsule laid open and turned back.

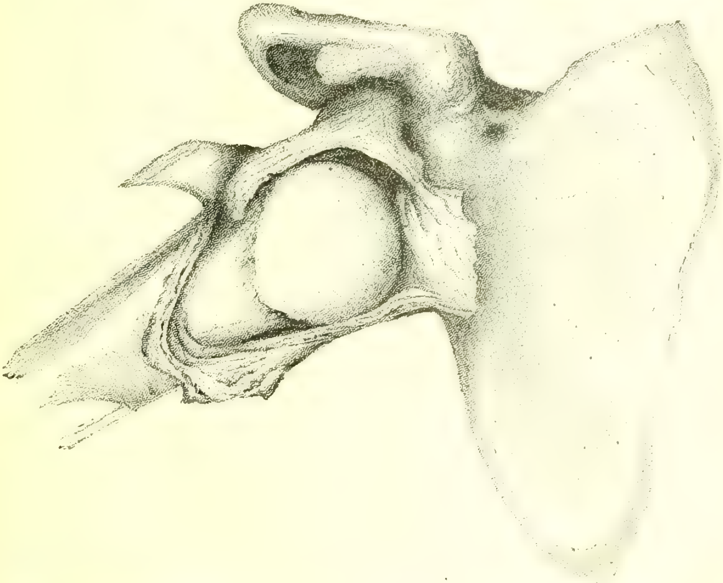


FIG. 195.—A similar dislocation, showing the effects of rotation outwards, abduction, and traction backwards. The head is just passing over the anterior edge of the glenoid.

help to manipulate the head of the bone. This lies underneath the subscapularis or in its substance, suspended as it were by the muscles and ligaments attached to the great tuberosity, and fixed firmly against the projecting anterior lip of the glenoid fossa (fig. 194).

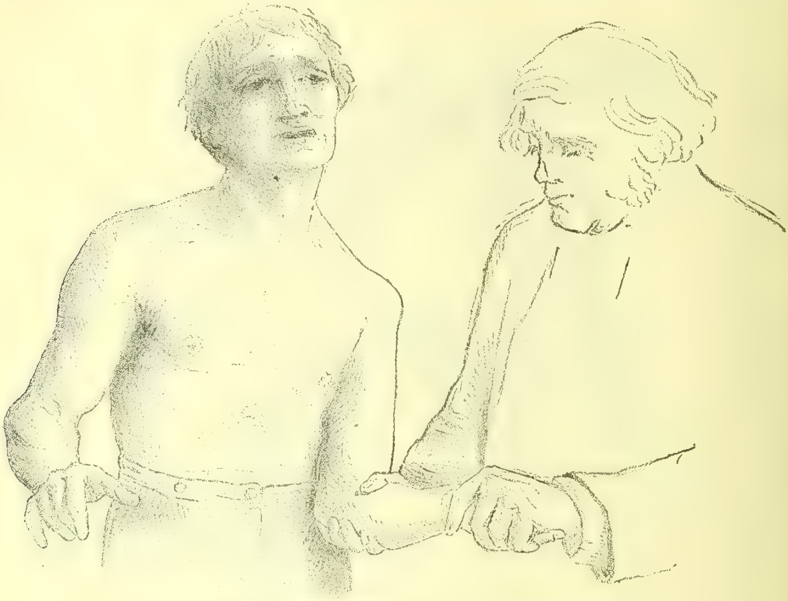


FIG. 196.—Rotation outwards, to be followed by abduction.

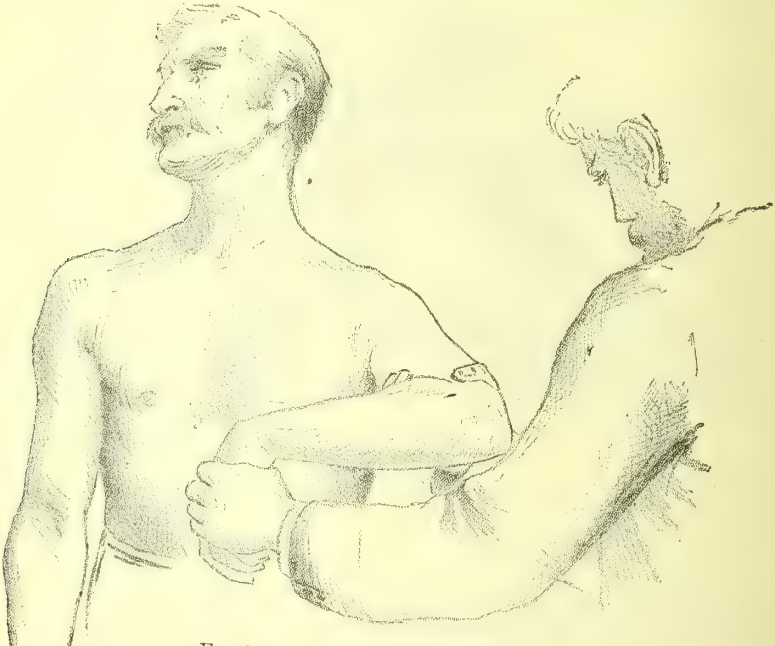


FIG. 197.—Circumduction of elbow, after rotation.

In many cases it may be released at once by rotation outwards, or rotation combined with traction. If the elbow (which is already flexed owing to tension on the biceps) is pressed firmly into the side, and then the forearm rotated outwards as far as it can go, the outer and posterior portions of the capsule, which are strained tightly against the glenoid fossa, are lifted away from it by the great tuberosity; the edges of the rent are held apart; and, if the opening is high up, as in most cases of subcoracoid dislocation, the head of the bone is fixed between the upper and lower parts of the capsule (both of which are still tense) on the anterior lip of the glenoid fossa, close to the spot at which it burst through (fig. 195). Sometimes then a little outward pressure from the axilla or backward traction from the elbow is sufficient to make it describe the arc of a circle, of which the upper untorn portion of the capsule is the radius, and it slips at once over the edge into its socket. A greater amount of force may be obtained by pulling the upper part of the humerus outwards, while the elbow is drawn across the front of the chest.

If this does not succeed, further manipulation must be tried: the forearm must still be kept flexed and rotated out as far as it will go, but the elbow must now be brought forwards until the arm is horizontal (fig. 196). By this the upper part of the capsule is relaxed, as well as the external rotator muscles, and the only portion left tense is the lower and posterior: this fixes the neck of the humerus and prevents the head from moving farther forwards. If now the forearm is circumducted inwards, so that the fingers touch the other shoulder, the head of the bone is forced to move in the opposite direction and can hardly fail to be carried into its socket (fig. 197). It is essential, however, that the movements should be carried out slowly and deliberately and to their full extent.

Inward rotation from the first is simpler still, and is more successful when the rent in the capsule is low down, as in the subglenoid form. The position of the patient is the same; the same precaution must be taken with regard to the elbow and the shoulder; then the arm is a little abducted, drawn down to release the head from the fibres of the muscle that surround it, and rotated in (fig. 198). The coraco-humeral band and the short external rotators are stretched as tightly as they can be, and the head of the bone travels round the inner margin of the glenoid fossa until it is compelled to rise over the edge. Drawing the lower end of the humerus

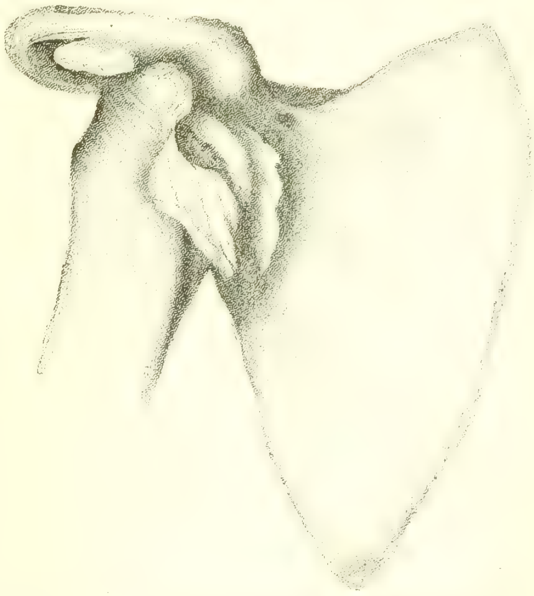


Fig. 198.—Forced rotation inwards, tightening up the short external rotators and the untorn parts of the capsule.

across the body, while the upper part is either being pulled or pressed outwards at the same time, is of great assistance.

If manipulation and rotation both fail (and even when the patient is under an anæsthetic, they will do so sometimes, either because of the peculiar position of the rent in the capsule, or from the changes that occur when the case is left to itself) extension must be tried. The most successful of all methods is by means of the heel in the axilla. The patient is directed to lie down upon a low couch, close to the edge; the surgeon (having first removed his boot) seats himself on the edge on the same side as the dislocated arm, facing the patient; he then takes hold of the limb by the wrist, and placing his heel (not the sole) well up in the axilla, so that it comes in contact with the axillary border of the scapula, proceeds to make traction upon the limb in its abnormal direction, slightly abducted, that is to say (fig. 199). The foot acts as a counter-extending force; the heel and the traction combined fix the scapula; and if the arm is rotated a little or gently swayed from side to side, or if the head of the bone can be manipulated from above by an assistant, it slips out at once, and is carried up by the muscles into the fossa with a sudden snap. In older cases, or when the muscles are relaxed by an anæsthetic, the foot has to act the part of a fulcrum as well; the head of the bone is gradually drawn down until it is disengaged; then the hand is brought across the chest, and the upper end of the humerus is levered outwards in the direction of its socket.

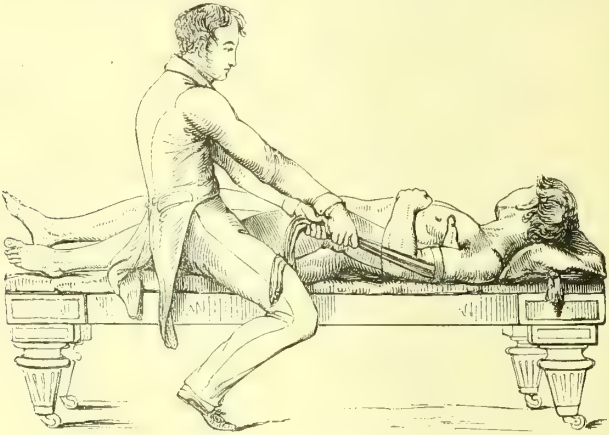


Fig. 199.—Reduction of dislocation by heel in the axilla.

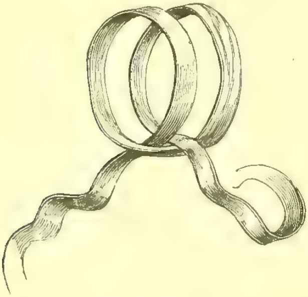


Fig. 200.—Clove-hitch.

A greater amount of force may be obtained by means of a jack-towel made into a clove-hitch. A wet bandage must first be placed round the arm to protect the skin as well as to prevent the towel slipping; the clove-hitch is adjusted above the elbow; and the loop of the towel passed over one shoulder of the operator and under the other arm; by this means he can bring into play the extensor muscles of the back and at the same time leave his hands free to grasp the wrist and aid in reduction by rotating and abducting the arm. In cases of still longer standing, in which rotation has failed, and it is considered advisable to make further trial, the pulleys may be adjusted to the arm above the elbow in the manner already described.

The same result is aimed at by means of the knee in the axilla (Astley Cooper's method), but it is not so successful: the patient is seated on a low chair; the surgeon stands behind, and resting his foot upon the edge of the chair places his knee in the axilla; then, grasping the arm above the elbow with one hand, and pressing down upon the acromion with the other, he makes traction downwards, and at the same time, by raising his foot upon his toes, forces the neck of the humerus outwards, thus combining traction and abduction with leverage.

One other method, that of hyper-abduction, must be mentioned, as the principle upon which it is conducted is rather different, and it sometimes succeeds when others fail. The arm is raised from the side, and abducted until it is in a line with the patient's body; the deltoid and the untorn part of the capsule are relaxed; the acromio-clavicular arch is made use of as a fulcrum, and the head of the bone is first of all pulled downwards, and then, as the scapula shifts, pulled out at right angles to the glenoid fossa, until it is sufficiently released to ride over its edge. It may be carried out in various ways. The patient may be seated on the floor, and the surgeon stand on a chair over him; or he may be lying down on a sofa, near the edge, so that nothing can impede the upward movement of the arm (fig. 201); and counter-extension may be effected, either by making a slit in a towel, passing the arm through it, and then giving it to someone else to hold on the opposite side of the patient, so that the scapula is pulled down upon the thorax—or by the surgeon himself pressing his foot or his hand down upon the shoulder from above and behind while making extension upon the arm. It is scarcely advisable for dislocations of long standing until other measures have been tried and failed, as, owing to the extent of movement of the head of the bone, it must expose the axillary vessels to a certain amount of risk.

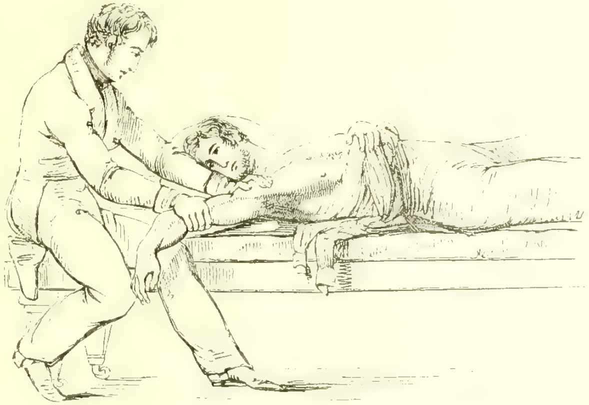


FIG. 201.—Reduction of dislocation by upward traction.

After reduction has been effected the axilla must be dusted over with oxide of zinc powder and carefully padded with cotton wool, partly to prevent any forward displacement of the arm, which might occur from the injury sustained by the muscles attached to the great tuberosity, partly to assist by its pressure in the absorption of the exudation that is thrown out. Then the arm must be bandaged to the side. Passive motion should be commenced not later than the end of the first week: if carefully carried out there is no risk of causing re-dislocation; and it is the best method for checking the stiffness that is liable to occur from confinement of the joint. Whether the limb after that period should be merely carried in a sling, or should each time be secured by bandages again, must depend upon the patient and the amount of care he will take of himself. Active movement should certainly not be allowed for three weeks, and no overhand movement for a much longer period.

Unreduced Dislocations

Dislocations of the humerus are very frequently neglected or overlooked, and it is by no means uncommon for the patient to apply for treatment for the first time months after the accident. The question then arises whether an attempt should be made to effect reduction, or whether it would not be better merely to break down the adhesions, and, by means of exercise and passive motion, encourage as far as possible the formation of a new joint. The time that has elapsed is of course the most important element, but it is not the only one—the age of the patient and the usefulness of the arm have to be considered. Up to four months success is common, and may be looked for, and the arm generally recovers; but many instances of failure, more or less complete, after much shorter periods than that, have been recorded. After four months it becomes more and more doubtful each day, although cases have succeeded after as long as two years. The best guide probably is the amount of pain the patient suffers: if it is severe—and sometimes it is so bad as to justify excision of the head of the humerus—the limb is sure to be kept at rest, and will become completely stiff; if, on the other hand, movement is already free and painless, and the part is fairly useful, it is certainly not advisable to try too much. The patient may be placed under an anæsthetic, the head of the humerus rotated from side to side, and the various methods of manipulation practised, with the prospect, even if reduction is not effected, of materially improving the use of the part; but if, after this has had a fair trial, the head of the bone shows no inclination to return, it is doubtful whether much improvement is likely to result from the use of the pulleys.

Complications.—Dislocations of the shoulder are always attended by bruising and laceration of the surrounding structures; but, unless the injury is very extensive or involves some part that usually escapes, it ought not to rank as a complication. Extravasation of blood into the axilla, for example, rarely deserves to be counted as one, though sometimes, owing to the number of small vessels torn across and the loose spaces in the cellular tissue, it is very considerable in amount; but occasionally *the axillary artery* gives way, or, what is equally grave, one of its large branches is torn off from it, and an arterial hæmatoma of the most serious description forms at once. The axilla becomes distended to its utmost; the pulse at the wrist ceases; the arm becomes œdematous and cold; and the patient falls into a state of collapse. In such a case there is no alternative: the subclavian must be compressed; the axilla opened; the blood turned out; and the artery tied above and below the seat of injury. Only when the swelling ceases to increase, while the arm still retains its warmth and feeling, is it admissible to wait. Possibly, when this is the case, the swelling has become accidentally circumscribed, and an aneurysm will form, which can be dealt with later on; or the opening in the artery has become temporarily blocked by a coagulum, which may not give way again, although it nearly always does. At any rate, in such circumstances there is no need to proceed at once to such a serious operation, although the case must be very carefully watched. Ligature of the subclavian, if the swelling is diffuse, will not check the hæmorrhage and may cause gangrene.

It is more common for the artery to be bruised by the head of the bone, but this rarely leads to anything more serious than a temporary cessation of the pulse. Sometimes, however, a thrombus forms, probably from the injury to the inner coat, and the artery is permanently closed; and occasionally an aneurysm develops later on. In a few instances *the vein* has been ruptured as well.

The brachial plexus, owing to its strength, nearly always escapes; but there is very often intense pain down some of the nerves from the pressure of the head of the humerus; and sometimes, probably from the same cause, this is followed by loss of power. It rarely, however, persists for any length of time. *The circumflex nerve* is not so fortunate. Atrophy of the deltoid is not uncommon after dislocations, and though in many instances it is the result of rheumatoid arthritis, setting in after the accident, sometimes at least it is due to the bruising or tearing this nerve has sustained.

The effect on *the muscles* has been already mentioned: the short external rotators suffer the most; sometimes they are completely torn across, or what is equally serious, drag away with them the great tuberosity. The others may be badly bruised, but there is seldom any graver injury; even the long tendon of the biceps, though it is subjected to a considerable strain, is very rarely torn or displaced.

Fracture of the surgical neck, whether it is the result of the original accident (the force continuing to act after the dislocation has been produced) or is due to attempts at reduction, is a most serious complication. In the former case the patient must be placed under an anæsthetic, and every effort made to manipulate the bone back into its socket: in the latter, it is probably best to push the upper end of the shaft into the glenoid fossa, and try to establish a false joint. *Fracture of the lip of the glenoid cavity* sometimes occurs, and, like separation of the greater tuberosity, is important, as it tends to impair the security of the joint after reduction.

These complications occur much more frequently from trying to reduce dislocations of long standing. Even when the attempt succeeds without much manipulation, the cellular tissue is bruised and torn, the adhesions broken down, and the muscles lacerated to such an extent that, especially if pulleys have been used, it is not uncommon to find the side of the chest and the axilla black and blue for weeks afterwards. But worse consequences than these have often happened. The bone, for example, has been broken many times, especially at the surgical neck; it becomes atrophied to a certain extent from disuse, and as soon as any leverage is put upon it, it gives way at its weakest part. The artery has been torn, and though on a few occasions this has been the result of excessive violence, it has happened to the most careful surgeons from mere manipulation. It is probably due to adhesions having formed between it and the head of the bone, so that, when the latter is moved to a very slight degree, the whole of the tension falls on a limited portion of the wall of the vessel. The same thing has happened to the vein: the brachial plexus has been torn out from the spinal cord; the ribs have been broken; the soft parts hopelessly damaged; and even the arm itself has been torn off.

Compound dislocations are very rare, and the treatment must be guided by the amount of injury sustained by the soft structures round the joint; unless these are very extensively hurt, the dislocation should be reduced and an attempt made to save the limb.

DISLOCATIONS AT THE ELBOW-JOINT

Under this are included dislocations of the ulna and radius together, of either of the two by itself and of the two separately, the one being driven forwards and the other backwards. Of these the first named and dislocation of the radius by itself are common, the others are very rare. They may occur at all ages, but, owing to the smooth and rounded shape of the articular surfaces in childhood, they are much more frequently met with at this period than in any other. All the processes, especially the coronoid at that time of life, are low and cartilaginous; the depressions are not deep or well-defined; and the head of the radius is not only smaller in proportion to the shaft, but is not marked off from it so distinctly as it is in later years.

Dislocation of Radius and Ulna together

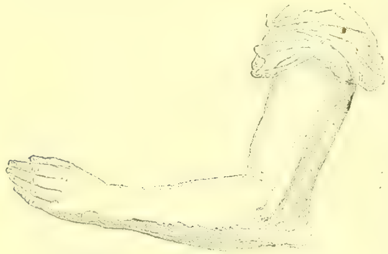


FIG. 202.—Dislocation of bones of forearm (back).

This may be complete or incomplete, that is to say, the two bones may either have lost all relation to the lower end of the humerus, or they may still be to a certain extent in contact with it, and it may take place in any one of the four directions, backwards (fig. 202), forwards, outwards, or inwards; or it may be diagonal, backwards and outwards, or backwards and inwards. Of these the dislocations backwards, and backwards and outwards, are the two most common; the others are very rare, the prominence of the olecranon prevents one, the direction and shape of the trochlear surface of the humerus prevents another, and complete lateral dislocation in either direction can hardly take place without the injury becoming compound.

Causes.—These injuries are nearly always the result of a fall upon the hand, with or without violence applied to the elbow itself, but the way in which they are produced is not always the same. In many cases they are due to over-extension: the tip of the olecranon is pressed against the posterior surface of the humerus, and forms the fixed point; then, if the force continues, the strain falls upon the anterior ligament, the biceps and brachialis anticus being either overcome or taken unawares; the sigmoid cavity of the ulna is separated from the trochlea, and the two bones are carried together, behind the humerus, until the coronoid process passes the centre of the articular surface. If it is carried right up to the olecranon fossa (it cannot lodge in it so long as the radio-ulnar ligaments are intact), the dislocation is complete ; if it falls short of this it is incomplete.

Dislocation backwards and outwards (which corresponds very nearly to that described by Malgaigne as ' incomplete backwards ') can also be produced by over-extension. In a fall upon the hand the arm forms a rigid bar between the resistance in front and the momentum of the body behind ; if, at the moment that the bones are separating and the ulna slipping behind the humerus, the elbow bends a little to one side, the strain falls upon one of the lateral ligaments more than on the other, and the displacement becomes diagonal, nearly always backwards and outwards.

In many instances, however, leaving dislocation forwards and directly outwards altogether on one side, over-extension never takes place. The primary displacement is due either to lateral bending or to rotation inwards, and when the coronoid process has in this way been shifted from its position in front of the trochlea, the bones are carried upwards and backwards by the muscles. This is easily accomplished in children. The hand is fixed by the momentum of the fall, the inner side of the forearm or elbow comes into contact with the ground, the internal lateral ligament tears across, or the internal epicondyle gives way, either from direct violence or because it is unequal to the strain, the sigmoid cavity is separated slightly from the trochlea, and the ulna is dragged upwards and backwards. The amount of lateral displacement depends upon the degree of force applied to the side of the elbow ; I have known pure outward dislocation (incomplete) caused in this way even in an adult ; more often it is backwards and outwards, and occasionally it is directly backwards.

Dislocation inwards and complete dislocation outwards (in which the ulna as well as the radius is carried to the outer side of the capitellum) can only be produced by a very great degree of violence applied directly to the joint. Dislocation of both bones forwards, so that the olecranon rests against the anterior surface of the humerus, has been caused on several occasions by a blow on the back of the joint when in a position of extreme flexion.

Symptoms and Diagnosis.—In adults it is generally easy to say whether there is a dislocation, though it may be very difficult to determine the exact extent of the injury ; in children, on the other hand, it is often impossible to come to a conclusion without a prolonged examination under an anæsthetic. The injury is frequently complicated by fracture or by separation of the epiphyses ; the bony prominences are not well defined or easily felt, and the part becomes so swollen in the course of a few minutes that accurate measurements are almost out of the question.

Dislocation backwards is the most characteristic : the forearm is flexed almost to a right angle and shortened, the hand is generally supinated (it may be pronated), the tip of the olecranon stands out behind, and the triceps runs down towards it, leaving a well-marked hollow on either side ; while in front, especially if the arm is slightly extended, the lower end of the humerus projects beneath the skin, filling up the hollow of the elbow. Active movement is out of the question, passive is very much restricted, and any attempt causes severe pain. But the most important test is the relative position of the bony prominences : when the elbow is at a right angle a line drawn horizontally from one epicondyle to the other lies above the tip of the olecranon ; the head of the radius can be felt and can be made to rotate about half an inch in front of the external condyle, and the olecranon fossa can be clearly made out. In dislocation—not only in dislocation backwards—this is all changed, the relations are no longer the same, and they are altered to such an extent that even when the swelling around the joint is extreme some essential difference can always be made out.

Dislocation backwards and outwards is more difficult, as all the signs are much less distinct. The position of the forearm is the same, but there is not so much shortening; the deformity is less; the head of the radius, instead of being clearly felt behind the external condyle, is partly concealed by it; the olecranon is scarcely more prominent than natural, as the sigmoid cavity embraces the capitellum to some extent, and it is hardly raised at all; passive motion is much more free; even a certain amount of active extension is possible; the external condyle and the external lateral ligament are unhurt, though the hollow behind is filled up, and the internal epicondyle is very often not so prominent as might be expected, as it is frequently either torn away or knocked off, and is partly buried behind the trochlea, partly concealed by the extravasation.

In the other forms of dislocation the deformity is so conspicuous that it can scarcely fail to be recognised at once.

The diagnosis has to be made from supra-condyloid and condyloid fracture, separation of the lower epiphysis of the humerus, wholly or in part, displacement backwards with fracture of the coronoid process, and effusion into the bursa behind the olecranon, which occasionally causes a deformity something like that of a dislocation.

The first named presents but little difficulty. It is true there is a prominence in front of the bend of the elbow, caused by the lower end of the upper fragment, and another behind, from the olecranon being carried backwards; but the former is always sharp and angular, not rounded like the articular surface of the humerus, and they can both be made to disappear and reappear by making or relaxing extension. Moreover, instead of the joint being rigid, there is undue mobility, the weight of the forearm causing it to drop at once; crepitus can usually be made out, and what is most important of all, the head of the radius and the olecranon preserve strictly their normal relation to the two condyles. The same may be said, with slight modification, of separation of either condyle; but in children, if the outer part of the lower epiphysis of the humerus is detached from the shaft, leaving the internal condyle unhurt, the difficulty of diagnosis is often very serious. Crepitus is absent, or there is only that soft variety which may be easily imitated in a dislocation; the swelling may be so great as to keep the joint rigid; the bony prominences are almost obscured; and unless great care is taken it is very easy to be deceived by the position of the olecranon, as, owing to its retaining its connection with the external part of the joint, it does not materially alter its relation to the line joining the two epicondyles. Both kinds of accident are of frequent occurrence, and as it is absolutely essential to form an accurate diagnosis, there should be no hesitation in giving an anæsthetic in order to make the examination as thorough as possible. If the displacement is not corrected, or if the olecranon fossa becomes partly filled up, the range of movement is seriously interfered with. I have known the same difficulty occur in adults when the external condyle of the humerus was detached from the shaft, carrying the bones of the forearm with it.

Fracture of the coronoid process is a very rare complication, but may be suspected if, when the dislocation has been reduced, it returns again at once.

Treatment.—The chief obstacles are the tension of the muscles and the position of the coronoid process which catches behind the humerus. The former may of course be relaxed at once by an anæsthetic, but this is seldom necessary. In many instances, all that is required is to fix the humerus, pressing it somewhat backwards, and make slight traction upon the forearm in the extended position; the coronoid readily slips over the smooth cartilaginous surface, and the bones return at once with a jerk. If this does not succeed, a slight degree of over-extension will probably disengage it. Dislocation outwards, and outwards and backwards, may be reduced in the same way; the obstacles are the same. The lateral displacement, however, if strongly marked, should be corrected first; in one instance it is recorded that, owing to the soft structures catching behind the condyle, reduction was impossible.

The plan ordinarily described as Sir Astley Cooper's hardly ever fails, but it is open to some objections. According to his description, the patient is seated on a low chair, and the surgeon, placing his knee on the inner side of the elbow-joint, in the bend, takes hold of the wrist and flexes the arm. At the same time he presses upon the radius and ulna with his knee, so as to separate them from the humerus and disengage the coronoid process; while this pressure is sustained by the knee, the arm is to be forcibly but slowly bent, and the reduction is soon effected. The wrist is at the end of the long arm of a lever; the knee is the fulcrum; and the olecranon the short arm. The resistance to be overcome is made up of the muscles (on both sides of the joint), the lateral ligaments and the fascia; all of these structures must be torn or stretched sufficiently to allow the coronoid to slip under the humerus while the arm and forearm are at right angles to each other. The method is very successful; but if these structures are not already torn, they must give way, owing to the force that is used.

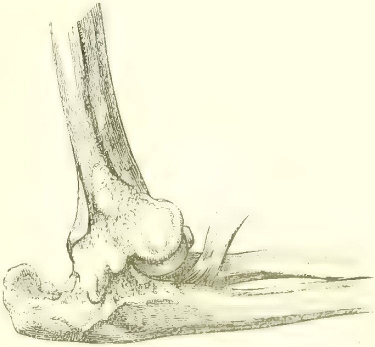


FIG. 203.—Unreduced dislocation of elbow.

The after-treatment is very simple. There is no fear of recurrence, as in the case of the humerus, unless the coronoid has been broken off; but the amount of extravasation and swelling is sometimes very considerable; and, especially in children, there is some risk of inflammation setting in. The limb should be placed on an inside angular splint, and cold and compression applied until the swelling has gone down and the fear of inflammation is past. Passive motion may in ordinary cases be commenced at the end of a week; after that, unless there is something unusual, it is sufficient if the forearm is supported in a sling. Perfect movement is generally regained, unless there has been a fracture through the lower end of the humerus.

Old dislocations may be reduced up to the end of three weeks or a month without much difficulty: after that it becomes doubtful, and though reduction has been accomplished as late as four months, this is quite the exception (fig. 203). In one or two cases in which all attempts have failed, and the position of the arm has been such that it was almost useless, the olecranon has been sawn through transversely from behind, the joint opened up, all obstructions divided, the muscles separated from the condyles, the olecranon fossa and the sigmoid cavity cleaned out, and the bone replaced. The olecranon must be wired together and the limb treated as after excision of the elbow. In some cases there has been distinct improvement, but in others, especially those in which there was at the same time a fracture through the lower end of the humerus the gain was not great; if suppuration sets in bony anchylosis is almost sure to follow.

Compound dislocations must be treated in the same way as compound fractures into the elbow-joint. The question turns first on the age and condition of the patient, then upon the extent of injury to the soft structures; and the choice lies between reduction, with an attempt to secure primary union of the wounds; reduction with free incision, and thorough (very thorough) drainage; excision, or amputation.

Dislocation of the Ulna by itself

is a very unusual occurrence, and is generally accompanied by partial displacement of the radius. Sometimes the separation is carried so far that the ligaments connecting the two bones are torn completely across, and one is displaced forwards and the other backwards. This can only be produced by extreme pronation: the ulna must be twisted on its axis until the internal lateral ligament gives way and the bone is forced behind the internal condyle. The forearm is held semi-flexed, but completely pronated.

Dislocation of the Radius

may be either forwards, backwards, or outwards: the first is the most common, the last very rare. In adults it seldom occurs unless there is fracture of the ulna; the force first breaks this bone, and then wrenches the radius from its socket. In children it is tolerably frequent, owing to the small size of the head, the absence of distinction between it and the shaft, and the comparative looseness of the orbicular ligament. The rent in the capsule is not always the same: in adults the ligament appears generally to be torn away from one or other end of the lesser sigmoid cavity; in infants and children, the head of the bone either slips out from under it or is forced through it, just where it is joined by the fibres of the external lateral ligament. Probably this serves to explain the serious difficulty that is occasionally met with in reduction.

Causes.—Dislocation of the radius by itself is nearly always the result of indirect violence—a fall upon the palm of the hand; but sometimes it is produced by pulling upon the forearm (swinging a child by the hand, for instance), and there are a few cases on record in which it has resulted from force applied directly to the elbow, the external condyle of the humerus or the capitellum being crushed first.

It is very doubtful if it can be produced by mere pronation; if this is carried to its fullest extent it makes the head of bone project against the front of the capsule; but before this gives way, either the internal lateral ligament tears across and both bones are dislocated backwards, or the radius itself breaks. The ulna in the living subject cannot act as a lever for the radius. It is possible that it may be effected by supination; but probably not as a rule, for, if the hand is violently supinated, the inferior radio-ulnar articulation gives way first, and then either the radius, or, in children, the lower epiphysis of the humerus. If, however, forcible lateral bending of the joint (adduction or abduction) is combined with pronation or supination, the orbicular ligament gives way readily, and the head of the bone is carried either forwards or backwards, according to the position of the elbow at the moment, and the direction of the force. In a fall upon the hand the limb is nearly or quite extended; its lower extremity is fixed against the ground; then the momentum of the body drives the elbow-joint to one side or the other, and at the same time violently pronates or supinates the forearm.

Symptoms.—The signs of this injury are usually distinct: the head of the radius projects, either in front of the joint under the supinators, or behind in the hollow below the external condyle; and its peculiar shape can be recognised at once on rotating the hand. The elbow is flexed; the radial side of the forearm appears shortened; generally it is moderately pronated, and sometimes this is extreme; voluntary movement is very much restricted, and passive motion, especially when the displacement is forwards, is limited by the head of the bone coming into contact with the anterior surface of the humerus. In older cases, when the articular end has become wasted and has worn a cavity for itself, this is more free; and sometimes, when it can slip to one side, a considerable degree of flexion is possible, but this is not common. The depression left by the displacement of the bone can always be felt below the external condyle.

Treatment.—Reduction may, as a rule, be readily accomplished by fixing the humerus, making extension from the hand, and pressing the head of the bone into position; but every now and then great difficulty is experienced, probably owing to the intervention of a portion of the capsule; and sometimes, in spite of manipulation in all directions, and pronation and supination, reduction remains impossible. If the orbicular ligament has given way, the difficulty of retaining the head of the bone in position is equally great: an anterior rectangular splint may be tried, or the limb may be put up in a position of complete extension with a pad over the head of the bone. If this fails, complete flexion sometimes answers, having regard to the circulation; but the condition is not unlikely to become permanent. Unreduced dislocations of the radius are not uncommon. If the head of the bone gives rise to serious inconvenience, if for example it prevents flexion of the elbow, or, from pressing upon the posterior interosseous nerve, interferes with the extensor muscles, it must be excised. Generally the arm regains a good deal of its power, partly no doubt because of the age at which the injury usually occurs; but pronation and supination are never very satisfactory.

Subluxation of the Radius

This accident, which was first correctly described by Duverney, is common in children under three years old, but is hardly ever met with after six. It is always produced in the same way: traction with adduction and possibly pronation. A young child is lifted up or swung round by the hand; there is a sudden cry of pain, and when the arm is released it either hangs helplessly down by the side or is supported across the chest in the flexed position. Nor is the child able to use it. In most cases no displacement can be found; sometimes the head of the radius appears slightly prominent in front, or is a very little separated from the capitellum; and sometimes there is a certain amount of swelling at the back of the wrist. Passive motion is perfectly free, and almost painless—in all directions except supination; that stops rather abruptly; and there is distinct tenderness and pain at the outer side of the elbow when it is attempted. In a few instances the wrist has been painful too.

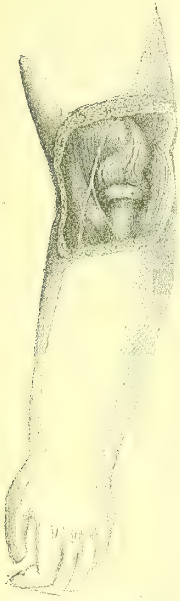


Fig. 204.—Subluxation of radius in an infant.

From experiments on dead subjects (there are no post-mortem records) it is tolerably clear that the symptoms are caused by the head of the radius being drawn out from inside the orbicular ligament until its anterior edge catches and is held below the lower border of the ring, thus slightly separating it from the capitellum (fig. 204). If in addition there is forced pronation, the head of the bone projects slightly in front (Pingaud). Possibly in those cases in which extreme pronation is the prominent cause, the displacement is made worse by the posterior portion of the head of the bone separating sufficiently from the capitellum to allow a portion of the capsule to be squeezed in between the two bones by atmospheric pressure. In either case reduction is usually effected at once by sudden extension combined with supination (J. Hutchinson, junior, recommends pronation with flexion); probably in many instances it takes place spontaneously; but, as Stimson remarks, there is reason to think that some cases of forward dislocation of the radius found in adults, persisting from childhood, were originally of this kind, the head of the bone gradually being displaced farther and farther.

Where the pain and swelling are confined to the back of the wrist-joint, without the elbow showing any sign, or where both parts are affected together, it is possible, as suggested by Goyraud, that the injury really consists in a dislocation of the triangular fibro-cartilage from the lower surface of the ulna.

DISLOCATION AT THE WRIST-JOINT

is a rare form of accident, which formerly was often confused with Colles' fracture. The carpus and hand are detached from the radius and fibro-cartilage and carried either towards the dorsum or the palm, according to the direction of the force. The projection on the back of the wrist, in the one case corresponding to the articular surface of the carpus, in the other to the lower end of the radius and ulna, can be recognised from its shape; but the most important sign is the position of the styloid processes: in dislocations their relation is normal; in fracture the radial one is separated and follows the hand. Reduction is easy, but, in spite of passive motion, is liable to be followed by stiffness.

Dislocation of the lower end of the radius, with rupture of the triangular fibro-cartilage, may occur from extreme pronation or supination.

In the transverse carpal dislocation the distal row of bones is separated from the proximal, and is driven either towards the palm or the dorsum; in the metacarpal the bones of the hand are displaced; but though this is not unfrequent in the case of the metacarpal bone of the thumb by itself, and occasionally happens to the others, there does not appear to be any instance in which it has involved all at once.

Dislocation of the os magnum by itself is not uncommon, the head of the bone being tilted out from the concavity of the semi-lunar by a fall upon the back of the hand. The projection can be recognised at once, and is easy to reduce, but it is very apt to recur, even though the hand is kept extended for two or three weeks. It is stated to be more common among women than men, and it has been produced by violent muscular contraction during parturition.

The pisiform bone, with the tendon of the flexor carpi ulnaris, is occasionally dislocated to one side, but this rarely happens to any of the others. They may be crushed and displaced in severe accidents, but then the injury is nearly always compound, and must be treated as a compound fracture into the wrist-joint.

Dislocation of the Metacarpal Bone of the Thumb

is nearly always dorsal, and may be easily recognised by the prominence on the trapezium and the shortening of the thumb, which is usually flexed. It may be the result of direct violence, as in the bursting of a gun, or of forced flexion into the palm of the hand. Usually there is no difficulty in the reduction, but sometimes it is almost impossible to keep the bone in position, probably because, in some of these instances at any rate, there is an oblique fracture running through the bone, detaching the palmar portion of its base.

Dislocation of the Proximal Phalanx of the Thumb

This, too, is usually dorsal (fig. 206), palmar displacement being prevented by the contact of the soft parts in flexion. The cause is forced extension: the palmar ligament is torn from the metacarpal bone close to its attachment, and the phalanx is carried backwards over the articular surface, until in complete cases it rests upon the neck, projecting almost at a right angle. One lateral ligament is generally torn, but both have been found intact; the tendons of the flexor brevis with the sesamoids lie on either side of the neck, and the distal phalanx is bent down by the tension of the long flexor, which usually lies to the inner side of the head of the metacarpal.

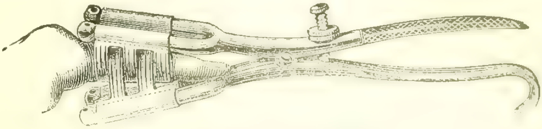


Fig. 205.—Thumb-forceps.

Reduction is sometimes quite easy; more often it is a matter of very great difficulty, and, occasionally, it cannot be effected at all. Chloroform is of very little help, and the numerous forceps that have been invented are not much more, for if the attempt succeeds it generally does so at once, and the hold on the thumb is quite sufficient (fig. 205).

The head of the metacarpal bone is prolonged inwards on its palmar aspect, so as to form a rounded eminence for articulation with the sesamoid bones. These are firmly united to the phalanx and to the palmar glenoid ligament which separates the long flexor tendon from the joint, and extends up on either side of the head, forming a large share of the socket. On the other hand the fibro-cartilaginous pad is very loosely attached to the metacarpal bone; and when dorsal extension is carried too far, tears off at once, and with the sesamoids follows all the movements of the phalanx.

Three forms of this dislocation have been described by Farabœuf, differing in degree.

1. *Incomplete.*—This can be produced in many young people voluntarily. The articular surfaces are not completely separated, and the phalanx is held by the tension of the muscles attached to its base, rigidly fixed on the dorsal edge of the articulation, from which it slips off with a jerk.

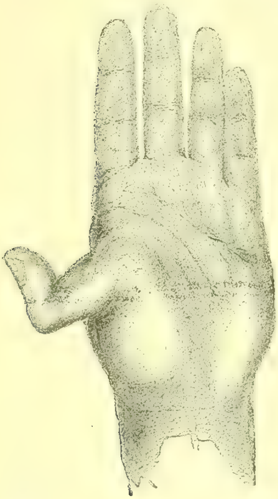


FIG. 206.—Dislocation of proximal phalanx of thumb.

2. *Complete.*—The articular surfaces completely separated; the base of the phalanx rests upon the dorsum of the metacarpal, dragging with it the glenoid ligament (which has been torn off) and the sesamoid bones; the tendon of the long flexor lies to the inner side (generally) and the head of the metacarpal projects through the rent in the capsule embraced by the muscles attached to the phalanx. The proximal phalanx projects at right angles, the terminal one is flexed strongly, and the head of the metacarpal stands out under the skin (fig. 207).

3. *Complex.*—If, in a complete dislocation, the phalanx is brought into a straight line with the metacarpal, the tension of the muscles on the sesamoid bones may pull them (and the glenoid ligament with them) backwards over the dorsal surface of the metacarpal, until they lie flat upon it. If now reduction is attempted the ligament is dragged over the head of the metacarpal by the phalanx until it is interposed between the two bones and effectually prevents proper apposition (fig. 208). This has been found by dissection on several occasions; in another a sesamoid bone was in the way, and in three, at least, the long flexor tendon had followed the ligament round the head of the bone, so that reduction was impossible until it was divided. Exactly the same occurs sometimes in the case of the fingers.

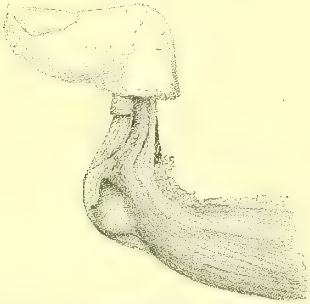


FIG. 207.—Complete dislocation of phalanx of thumb. The glenoid ligament torn from the metacarpal but preserving its normal relation.

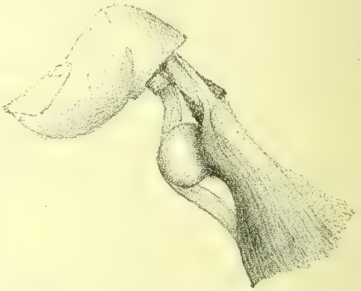


FIG. 208.—Complex dislocation. The glenoid ligament displaced on to the dorsal surface of the phalanx.

According to Farabœuf, complete dislocations are rendered complex by ill-advised manipulation, especially by premature attempts at flexion. The metacarpal bone must be pressed well down into the palm to relax the short muscles as far as possible; then the phalanx must be over-extended until its back nearly touches that of the metacarpal, and pushed forward along it until its edge slips on to the articular surface; then it suddenly becomes flexed. The position of the long flexor tendon, whether it lies to the inner or the outer side, should, if possible, be made out, as this is sometimes material. The former is the more common, and then as the phalanx is being brought up it should be slightly rotated, so as to bring its inner edge into position before the outer, and, if possible, push the tendon over the head of the bone in front of it.

In the complex form, when the sesamoids and the glenoid ligament are turned up behind the head of the metacarpal, the only hope lies in extreme extension of the phalanx, so that its dorsal surface shall touch that of the metacarpal before it is pushed on. In this way they can sometimes be lifted sufficiently to fall into their position again.

If this fails, it is better to abandon the attempt for a time and to keep the joint perfectly cool and quiet for a week or ten days; then a free incision may be made down one side, the cause of the difficulty ascertained and removed. Tenotomy of the flexor brevis has been recommended, but if the cause is the interposition of some extraneous substance, it would hardly meet the case. Division of the long flexor has been successful, and probably it would have succeeded in the three cases in which the tendon was found between the surfaces. No operation, however, may be attempted at once, or, owing to the bruising of the tissues, suppuration is almost certain to set in. As a last resort, the joint must be excised.

Old unreduced dislocations are not uncommon: the phalanx can be bent back almost on to the metacarpal, but cannot be brought quite into the same straight line, or flexed into the palm. The deformity is very unsightly, but the use of the part is singularly little affected.

Similar displacements occur in connection with the metacarpo-phalangeal and the inter-phalangeal joints of the fingers; the deformity is not so great as that of a real dislocation, and it cannot be rectified. In some instances the fibro-cartilaginous palmar ligament has been found between the bones, and has been removed; in one under my care the first attempt proved successful after division of the flexor tendon.

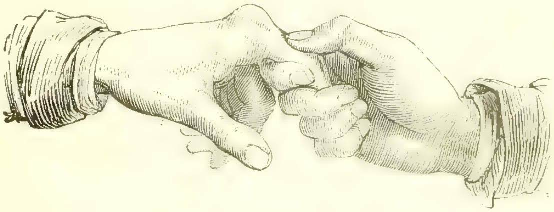


FIG. 209.—Dislocation of finger.

Besides this, true dislocations, both palmar and dorsal (fig. 209), are met with, but much more rarely.

DISLOCATIONS OF THE HIP-JOINT

In spite of the shape and depth of the acetabulum and of the strength of the muscles and ligaments that surround it, this accident is not so uncommon as might have been expected. This is due partly to the enormous leverage afforded by the lower limb, partly to the fact that in certain positions the head of the bone sinks to a great extent out of the cavity and rests against the weakest portion of the capsule. It may occur at any age, but naturally is much more common during adult life; in children it has occasionally been produced by direct traction upon the limb; as a rule it only results from extreme violence, when, for example, a man is crushed to the ground by a heavy weight falling on his back as he is stooping forwards.

VARIETIES

The head of the bone may come to rest at any point round the socket; but so long as the anterior portion of the capsule is untorn, its range is limited and it practically occupies one of three positions. These are known as regular dislocations, each having many sub-varieties, in contradistinction to the irregular or anomalous ones, in which, owing to this part of the capsule having given way, the neck of the femur is no longer fixed and the head may travel anywhere.

1. *Displacement backwards.*—The head of the bone rests on the dorsum of the ilium (fig. 210), or on the posterior surface of the ischium (fig. 211), somewhere between the edge of the acetabulum and the margin of the great sacrosciatic foramen: possibly on the spine of the ischium, but never in the foramen.

2. *Displacement downwards.*—The head of the bone rests on the thyroid foramen (fig. 212), hardly having moved after its immediate exit from the acetabulum; or it is carried farther still into the perinæum.

3. *Displacement inwards* on to the pubes, at the spot where the horizontal ramus joins the ilium (fig. 213).

In none of these is the anterior part of the capsule, the so-called Y ligament, torn; the rent lies behind, generally along the inner margin of the acetabulum and the posterior surface of the neck of the femur; the ligamentum teres is pulled in two, or more frequently separated from its pit on the femur, bringing away with it some of the articular cartilage; and the muscles round the joint, especially the short external rotators, are badly lacerated.

The mechanism of dislocation.—Except perhaps in pubic dislocation (which may be produced in extension) the limb is always flexed. If it is flexed and adducted, the head of the bone is driven directly through a tolerably strong part of the capsule on to the ilium or ischium; if it is flexed and abducted, the edge of the acetabulum acts as the fulcrum of a lever, the head is tilted out from its socket and slips through where the fibres are thinnest, at the lower and inner margin. Then it becomes displaced secondarily, either backwards or forwards, by the weight of the limb and the contraction of the muscles. It is still a matter of question which of these two (the direct or indirect) is the more common.

The shape of the acetabulum certainly favours the latter; the upper and back part of the cavity is of immense strength and very deep; the inner, on the other hand, is low and interrupted for nearly an inch by the cotyloid notch. In abduction the head of the bone rolls more and more towards this side until it projects above the edge, half resting against the weakest portion of the capsule. In this position a very slight push is sufficient to tear the thin membrane across, and, the round ligament being relaxed, to dislocate

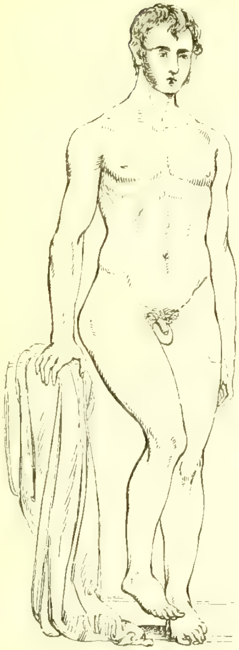


FIG. 210.—Dorsal dislocation.

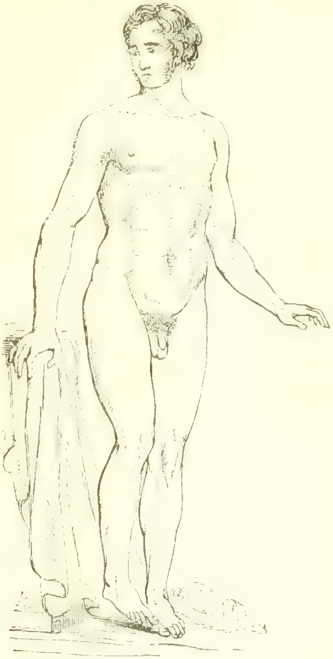


FIG. 211.—Sciatic dislocation.

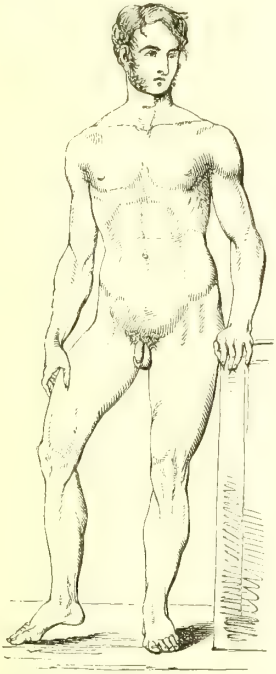


FIG. 212.—Thyroid dislocation.

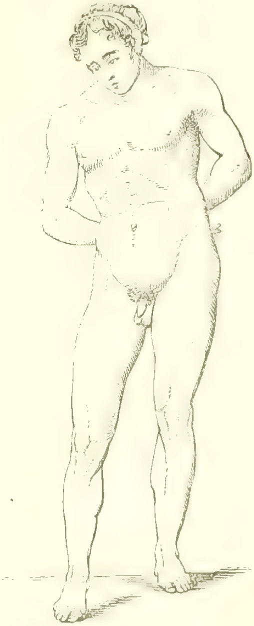


FIG. 213.—Pubic dislocation.

the head of the bone. Its ultimate resting-place is regulated by the degree of flexion and rotation. Sometimes it moves slightly inwards and remains on the thyroid foramen. Very rarely, only indeed when the limb is everted and extended, it ascends on to the pubes. Much more often, owing to the inversion of the head, it forces its way backwards, below the tendon of the obturator internus, and either remains upon some part of the ischium, or, if the capsule and the short external rotator muscles are badly torn, makes its way higher up until it lies upon the dorsum (fig. 215). According to this view, which is strongly advocated by Morris, all dislocations are primarily downwards, the head of the bone emerging somewhere between the ischial tuberosity and the thyroid foramen; the other varieties are merely consecutive displacements, due partly to the weight of the limb as it becomes extended, partly to muscular contraction; and the particular variety is dependent upon the position of the limb at the moment that the head is leaving the socket.

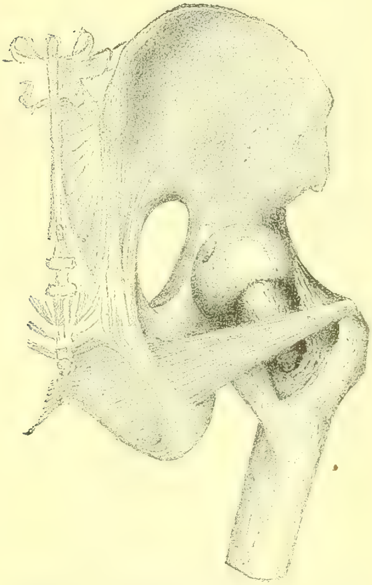


Fig. 214.—Dislocation on to dorsum above the tendon.

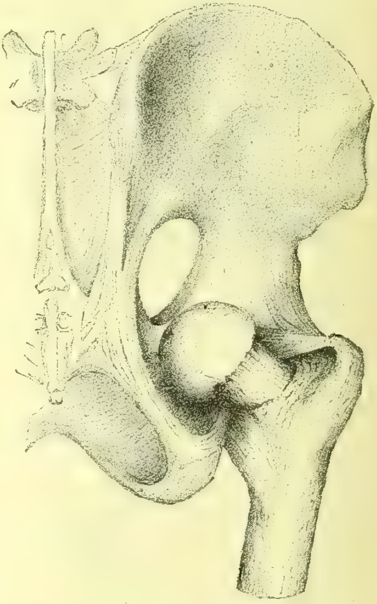


Fig. 215.—Dislocation on to sciatic notch below the tendon. Secondary displacement brings the two almost into the same position.

Now it is certainly true that sometimes during manipulation under an anæsthetic, instead of the head of the bone rising up into its socket, it rolls along the lower margin of the acetabulum, passing from the thyroid foramen to the ischium and back again, according to the position of the limb; and there is no doubt that all the four regular dislocations can be produced in this way in the dead subject; but it is no less true that this explanation will not serve in all cases. In many instances (probably in most) the limb, instead of being abducted, is strongly adducted at the moment of the accident; further, the rent in the capsule does not always run along the thinnest part, by the margin of the acetabulum and the posterior surface of the femur. The pubo-femoral portion of the capsule may be intact; and, as

Humphry has shown, there may be at the back a tri-radiate rent, forming a kind of valve, with its apex opposite the lower part of the tuberosity. Such an injury can only be produced by the head of the femur being driven directly backwards, in the flexed position. If the joint is nearly straight at the moment the limb receives the shock, the lip of the acetabulum may be chipped off; if moderately flexed, the head of the bone is driven out, above the obturator internus, or through its substance, tearing the capsule away from its attachment, or dragging off part of the bone (fig. 214); when the flexion is extreme (as it nearly always is in these accidents) the head passes out beneath the tendon (fig. 215), and either comes to rest upon the ischium, or, if the force continues to act after the dislocation is produced, tears its way farther through the muscles until it reaches the dorsum.

Dislocation backwards

This is by far the most common, and includes both the dorsal and the sciatic varieties; they are produced by the same kind of accident; the attitude of the limb is the same, although it varies in degree; and the method of reduction is the same. The difference depends upon the position of the rent in the capsule and the extent of the injury to the muscles. If the opening is high up, the displacement is dorsal from the first; if the lower part is torn, it is sciatic; but, if the rent is large and the short external rotators are much lacerated, the head of the bone ploughs its way up subsequently, and the sciatic dislocation becomes dorsal by secondary displacement.

Causes.—The most common is a violent blow upon the back, while the body is bent forward in a stooping position. The hip is always flexed; if the limb is adducted and inverted, the pelvis is driven down on to the femur until the head of the bone is forced through the capsule; if it is abducted and inverted, the pelvis is twisted, the head of the bone tilted out of the lowest part of the socket, and then forced below the tendon of the obturator internus. The ultimate position is the same, because that is dependent upon the untorn portion of the capsule and the muscles. Other causes are falling with the legs wide apart; sudden abduction of one limb when the other slips down a hole; or a wheel passing over the hip. One case of double dislocation is especially important: a man was standing on an incline with his feet wide apart, the right leg being lower down and therefore straighter than the left; suddenly he was crushed to the ground by a heavy weight falling upon his back; both hips were dislocated at the same instant; the right, which was least flexed, was driven on to the dorsum; the left on to the sciatic notch.

Pathology.—The round ligament is almost always broken; sometimes it is pulled away from the bone; the inner or posterior part of the capsule is torn, as described already; or the back part of the acetabulum is dragged off; the short external rotators always suffer; in some cases they are completely ruptured, and the head of the bone lies in the substance of the glutæi; in others the quadratus femoris and the inferior gemellus only are lacerated, though the rest are bruised by the pressure of the bone; the pectineus usually gives way, and the psoas and iliacus are very much stretched. Occasionally the great sciatic nerve is seriously injured, either from the accident itself or from the efforts at reduction. The anterior part of the capsule is always intact, generally it is very tense, but this is not invariable.

Symptoms and diagnosis.—Dislocation on the dorsum can be recognised at once by the position of the limb. The thigh is flexed, adducted, and inverted until the axis of the femur crosses the lower third of the opposite one; the knee is semi-flexed, and the ball of the great toe rests upon the instep of the other foot. In the sciatic this is less conspicuous: the limb is nearly straight, and almost extended; although, immediately after the accident, the inversion is sometimes even greater. The contour of the hip is altered, the extent varying with the condition of the patient. The buttock is flattened, and broader than the other; the glutæal fold is raised, and the trochanter more prominent; it rises above Nélaton's line, and approaches the anterior superior spine; but in this respect again sciatic dislocation is much less distinct than dorsal.

The next thing is to confirm this by measurement. The limb is always shortened: in the dorsal dislocation as much as two and even three inches; in the sciatic rarely more than one; and as this takes place entirely at the hip-joint, it may be appreciated best by Bryant's triangle, the three sides of which all measure less than normal. It is noteworthy that in sciatic dislocation, owing to the head of the bone lying behind the acetabulum, though the amount of shortening is slight when the limb is extended, it becomes very conspicuous as soon as it is flexed to a right angle (fig. 216).

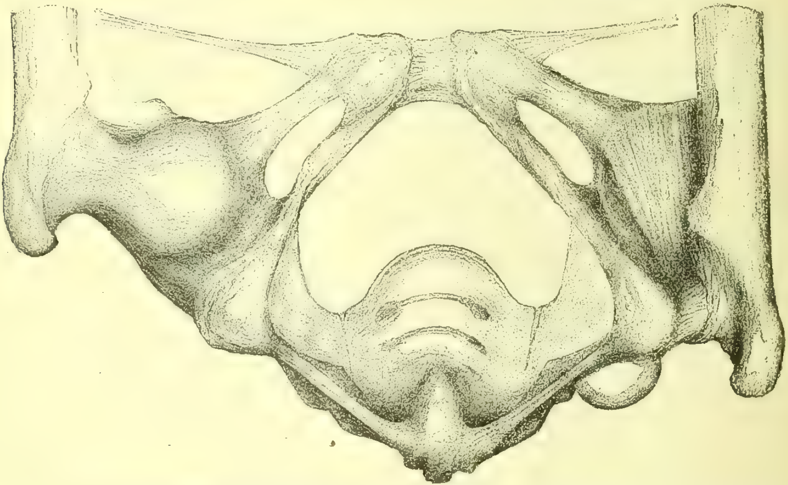


FIG. 216.—View of pelvis from below, with hips flexed to a right angle, showing the difference in position and the amount of shortening in a case of sciatic dislocation.

The head of the bone can be generally felt by deep pressure where the dislocation is on the dorsum, unless the patient is very stout; but this is rarely possible in the sciatic form, even when the limb is rotated from side to side. There is often, it is true, a sense of resistance; but that is all. In one or two instances the head of the bone has been felt per vaginam. In front, the hollow left can be readily appreciated, even in a moderately stout person, the femoral vessels seeming to dip back suddenly after passing under Poupart's ligament. In thin people the finger seems to sink almost into the acetabulum.

Passive motion, which should always be left to the last, is conclusive. If the knee and hip are flexed, so that the sole of the foot rests on the bed by the side of the other knee, it is impossible to evert the limb: the opposite side of the pelvis rises at once. In any case of fracture (except in that very rare accident in which the head of the bone is driven through the floor of the acetabulum), if the limb is not already in this position, it can be made to assume it so easily that it appears to fall out almost of its own weight.

Voluntary movements are very much restricted; of passive ones flexion is the least affected; the limb cannot be completely extended, and abduction, adduction, and rotation are all limited. Sometimes, however, in a sciatic dislocation a few days old, the range of passive motion is nearly as wide and as easy as in the uninjured limb, with the exception of abduction and eversion when the hip is flexed, and the power of voluntary action is to a great extent regained.

Pain, of course, is always present; in many instances it is very severe, and it may extend down the course of the sciatic nerve; the back is arched, especially if any attempt is made to extend the limb, and spurious crepitus can nearly always be felt on manipulation. Sometimes, if the lip of the acetabulum has been broken, true crepitus can be felt as well, but only by direct pressure above and behind the trochanter while traction is being made upon the limb.

In no case is it wise to come to a conclusion without examining the patient under an anæsthetic, not only on account of pain, but because, unless the dislocation is very recent, it is impossible to manipulate the limb sufficiently freely. Impacted fracture of the neck of the femur with inversion of the limb is the most difficult to distinguish, especially if a portion of the trochanter has been broken off: for this, if pulled up on to the dorsum, may easily be mistaken for the head of the bone; but the range of passive motion is totally different. Fracture of the lip of the acetabulum, if the portion broken off is small, will probably escape notice altogether; but if the cup is much injured, the head of the femur slips out on to the ilium, and the limb assumes the position of a dislocation. Reduction is easy, but as soon as the limb is left to itself it resumes its former attitude.

Treatment.—Dislocation backwards is always caused by flexion, and, unless everything that resists is torn across, can only be reduced by flexion. The thigh is bent at the moment of the accident, generally to its fullest extent, whatever attitude it assumes afterwards, and the first thing to do is to restore it to this position, so as to bring the head of the bone opposite the rent through which it escaped.

The knee must be bent to relax the hamstrings and the sciatic nerve; and then the hip, until the front of the thigh is pressed against the abdomen. The ilio-femoral band is relaxed by this, the femur is brought into its proper line, the inversion ceases, because now there is no tension on the external limb of the Y-ligament, and the head of the bone is lifted out from between the rotator muscles until it rests under the margin of the acetabulum. Sometimes a little adduction or rotation inwards helps to push the tendons aside. If now the pelvis is held down by pressure upon the ilia, and the knee is lifted vertically upwards, in many cases the head of the bone slips at once over the rim into its socket. The amount of force required is very slight, especially if the patient is under an anæsthetic.

If this does not answer, there must be some mechanical reason for it. The neck of the bone may be entangled in the obturator internus tendon; or the sciatic nerve, or the tendon of the obturator externus, may be twisted around it; the rent in the capsule may be more on one side; or a portion of muscle or of the capsule may constantly get in the way and partly fill the cavity. Whatever it is, an attempt must be made by rotating the limb from side to side, and by abducting and adducting it, to stretch the opening and disengage the head.

The next proceeding, if the head of the bone cannot be lifted directly into its socket, is to try and tilt it in by turning the femur into a lever. The base of the neck is fixed by the Y-shaped ligament, and forms the fulcrum: the limb is the long arm, and the head the short one, so that the power is enormous. The thigh is flexed as before, but slightly abducted: this brings the head a little towards the inner side of the cup, where the rim is lowest, and helps also to stretch the opening in the capsule. Then, if it is rotated outwards and extended, the ilio-femoral band is tightened up and the head is forced to travel round the cavity until it reaches the lowest part of the rim, over which it rolls at once. During the first part of the manipulation the thigh should be forced down upon the abdomen, as the object is to raise the head from among the muscles; but when the limb is being rotated, as a preliminary to extension, it should be held at right angles to the body; if it is more flexed than this, or if it is much abducted, the head of the bone, when the limb descends, slips to the inner side of the acetabulum, instead of rising over the edge, and the dislocation becomes thyroid.

These two methods have practically superseded extension; even for old dislocations it is never used now, unless they have failed. Sometimes the ilio-femoral ligament is partly torn, so that the fulcrum is not held firm, or a fold of the capsule gets in the way, or the head is so surrounded and buttonholed that it cannot be released, and then extension is the only thing left; but, as a rule, in these circumstances, the parts are so torn (to some extent by the manipulation) that it can be done by the hands at once, or a jack-towel, and pulleys are not required.

Thyroid Dislocation

Thyroid dislocation (dislocation downwards or downwards and forwards into the obturator foramen) is much more rare. It can only be caused by abduction, combined with slight eversion, and of the four regular dislocations is the one that undergoes the least degree of consecutive displacement. Jumping from a height with the feet wide apart, or the sudden movement of a carriage while a person is in the act of mounting, may be regarded as typical. The head of the bone lies upon the thyroid foramen, in the substance of the obturator externus, below and a little to the inner side of the acetabulum; the rent in the capsule runs through the thinnest part, but the pubo-femoral band may be torn as well; the ligamentum teres is ruptured, the pectineus and the adductors very much stretched and generally torn, and the anterior part of the capsule and the ilio-psoas as tense as they can be.

The position is unmistakable: the patient lies with the body bent towards the injured side, and the pelvis tilted in such a way that the limb appears much longer than its fellow; the knee is bent, the foot everted, and the thigh abducted and flexed. The degree to which this takes place depends upon the ilio-femoral band and the psoas; the farther the head is from the acetabulum, the greater the amount of distorsion. Actual measurement shows that the limb is really shortened. The trochanter is sunken inwards, the glutæal fold is lowered, the adductors stand out rigidly on the inner side of the thigh, and the head of the bone can generally be felt. Voluntary movement is out of the question ; passive flexion is fairly easy ; but, so long as it is extended, the limb cannot be inverted or brought to the middle line. If the dislocation is unreduced, the limb gradually becomes straighter and may acquire a considerable range of movement, but not so much as in the case of the sciatic.

Reduction may be effected either by vertical extension or leverage, as in the dorsal form, only adduction and inversion must be used instead of abduction and eversion. The patient should be placed under an anæsthetic, the limb flexed right on to the abdomen, bringing it gradually into its normal line, and then an attempt made to lift it vertically upwards into its socket. If this does not succeed, in spite of lateral movements to release the head and stretch the capsule out, rotation must be tried. The limb is flexed to a right angle, adducted, rotated inwards and extended. The mechanism is the same as in the dorsal form, and if the degree of flexion or adduction is too great, the head of the bone slips round the lower margin of the acetabulum in a similar way (but in the opposite direction), instead of rising over the edge.

Pubic Dislocation

Dislocation on to the body of the pubes, not merely on to the front of the bone, is still more rare. It can only occur when the limb is extended and abducted, and it may be caused either indirectly by this movement being carried too far, or directly by violence applied to the back of the hip. The head of the bone rests upon the point of junction of the ilium with the pubes, outside the femoral vessels, and under Poupart's ligament. The rent in the capsule is a little higher up than usual, the round ligament, the pectineus and the adductors are always more or less torn, and sometimes Poupart's ligament ; and the short external rotators, especially the obturator internus, are forcibly stretched and hold the limb down.

The limb is everted, abducted, and nearly straight. The trochanter is more sunken than in the thyroid form, the head of the bone can be felt distinctly in its new situation, and in most cases can be seen. There is shortening, generally, to the extent of an inch. Flexion, without drawing the head of the bone down, or abducting the limb first, is only allowed to a slight extent ; abduction is fairly free.

The mechanism of reduction is the same as for thyroid dislocation ; only, because of the position of the head of the bone, the limb must be abducted while it is being flexed so as to bring it round the acetabulum. Vertical extension may fail, owing to the capsule being torn more on the inner side than below ; but rotation is nearly sure to succeed ; if it does not, extension, with direct pressure upon the head and the upper part of the thigh, must be tried.

ANOMALOUS DISLOCATIONS

Besides these dislocations there are others, either intermediate in their haracter or exaggerated, owing to the amount of laceration and to the istance that the head of the bone has been carried. Generally speaking, hey may be grouped round the regular forms and classified, either by the ttitude of the limb or the method of reduction. The head of the bone, for example, may rest upon the ischium immediately below the acetabulum, opposite the point from which it has escaped, without passing either forwards or backwards. Secondary displacement has been in some way prevented, and the limb is inverted and strongly flexed. (This may be compared with the luxatio erecta of the humerus.) From this point the head of the bone may be carried towards the tuberosity, or on to some part of the margin of the great sacro-sciatic foramen, until it is fixed in one of the ordinary positions.

In other cases, the head of the bone is forced so far inwards that it passes from the obturator foramen into the perinæum, and the abduction, flexion, and eversion become extreme. I have seen, in a case of this kind, the thigh laid completely on its outer side and flexed to less than a right angle.

Most of these irregular forms, however, belong to the pubic group; the head of the bone may lie just internal to the anterior inferior spine, or it may be carried beyond it or even above it, until it rests in the notch between the two spines (the supra-spinous variety). The attitude of the limb and the other symptoms are the same as in the pubic form, only much exaggerated, and reduction must be carried out in the same way, by abduction and flexion first, and then inversion, adduction, and extension.

After-treatment.—It occasionally happens that, after reduction has been accomplished, the head of the bone slips out again as soon as the effects of the anæsthetic pass off. In old dislocations, this may be due to the cotyloid cavity being partly filled up; in recent ones it is the result either of some portion of the capsule having fallen into the acetabulum in front of the head of the bone, or to part of the rim being dragged away. In either case reduction must be effected again, and a long splint and weight extension applied before consciousness returns, in order to ensure the position being maintained. The limb should be kept quiet in such a case for at least four weeks.

Under ordinary circumstances, where there is no tendency to redisplacement, it is sufficient to confine the limb between sand-bags, and passive motion may be commenced at the end of a week.

Old Dislocations

If not of more than two months' standing, there is a fair prospect of success; in one case, reduction was accomplished at the end of a twelve-month, but this must be regarded as quite exceptional. Manipulation under an anæsthetic affords a much better chance than extension, even with the aid of pulleys (fig. 217). If the head of the bone is not reduced, the adhesions are

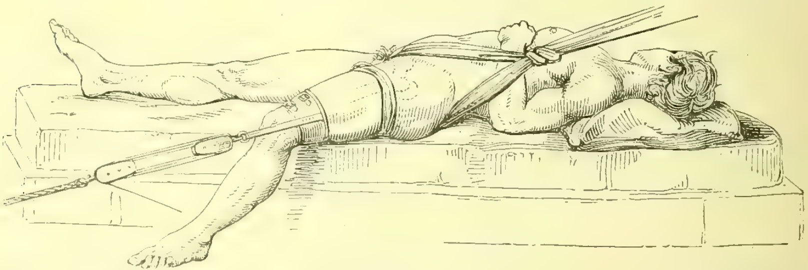


FIG. 217.—Showing the fashion of applying pulleys. (N.B.—The leg and thigh should be bandaged.)

broken down, the range of movement is much improved, and, especially in the sciatic form, the limb regains a great deal of its strength and activity, a new cavity gradually being developed for the head. Care, however, must be taken not to fracture the femur, which is very often atrophied from disuse, or to injure the sciatic nerve, which sometimes is wound around the neck of the bone. Both of these accidents have been met with in recent dislocations, but they are much more likely to happen in old ones.

Excision of the head of the bone has been performed in several cases with a very satisfactory result, though the operation is a serious one. If the head is fairly movable, but the position of the limb faulty, subtrochanteric osteotomy may be tried instead.

DISLOCATION OF THE PATELLA

This may be dislocated to either side, or it may be twisted on its vertical axis so far that the articular and cutaneous surfaces are almost reversed. Displacement upwards can only be regarded as part of rupture of the ligamentum patellæ.

Outward dislocation is the most common, especially if there is any genu valgum. It can only occur in extension: the patella then is so loosely held that it can be pushed from side to side, and can be dislocated either by muscular action, or by a sudden blow upon its inner border, tilting it out over the external condyle; in flexion it sinks in between the condyles and is held strapped down by the tension of the muscles. If the dislocation is complete, the articular surface rests against the outer side of the external condyle; if it is only partial, the bone is not carried so far and the margin looks forwards. Laceration of the capsule is very general, but apparently not absolutely essential. Dislocation inwards and rotation are both very rare; the latter has been produced by a violent blow upon the inner side of the bone when the knee was bent to an acute angle.

The deformity can usually be recognised at once: the limb is extended or very slightly flexed; the knee is flattened in front and broader than natural; a hollow can be felt between the condyles; and the shape of the patella, with the ligamentum patellæ and the tendon of the quadriceps, both of which are very tense, can be seen standing out beneath the skin. Movement is very limited.

Treatment.—Generally, if the hip is flexed, the knee extended, and direct pressure made upon the prominent border of the bone, it slips back into its position at once; or, if this fails, the hip and the knee may be bent, (under an anæsthetic) and pressure and extension tried together; sometimes rotation of the leg has been found of assistance. But, while one or other of these nearly always succeeds at once, instances are occasionally met with in which reduction is impossible in spite of every attempt. Nor is the cause clear. It may be due to the patella catching in the intercondyloid notch, or to its being in some way entangled in the capsule; but, whatever it is, in a few cases it has resisted everything, and the dislocation has remained unreduced in spite of section of the ligaments and the tendon of the quadriceps. In such circumstances it would be wiser to open the joint freely, with every precaution, and divide the structures that retain the bone, than to trust to force and subcutaneous section, which on several occasions have ended in suppuration.

As in all injuries involving the knee, the joint becomes filled with fluid even before the dislocation is reduced; and partly for this reason, the capsule becoming stretched and softened by the effusion, partly because the dislocation is due in great measure to the shape of the bones, recurrence is very common. The limb must be placed upon a splint, in a position of moderate extension, carefully packed in cotton-wool, and firmly bandaged until the effusion is absorbed. Afterwards an apparatus must be worn to prevent any lateral movement of the patella. The simplest, perhaps, is a piece of chamois leather spread with lead plaster strained round the limb; it should be large enough, when the knee is laid upon it, to overlap well in front, and should extend a few inches above and below the joint. This answers better than ordinary strapping, unless it is applied exceedingly well. If, however, there is much laceration, or if the bone has been displaced more than once, some apparatus similar to that used to retain a displaced fibro-cartilage is advisable.

In young people of rapid growth, when the bony prominences are poorly marked and the ligaments yielding, the patella can be moved freely from one condyle to the other, and sometimes it gets caught upon the outer one. The capsule, however, is not torn; the bone is easily replaced; and there is a very slight amount of effusion afterwards.

DISLOCATIONS OF THE KNEE

The leg may be dislocated backwards, forwards, or to either side; and a few cases are recorded in which the tibia has been displaced so far by rotation that the inner tuberosity was directed forwards and the tubercle outwards.

Lateral dislocations are the most common and are always incomplete, the tibia never being displaced entirely from the femur. They may be caused by a fall with the leg bent under the body, by sudden forcible twisting, or by extreme violence applied to one side of the limb; and are always attended by very serious injury to the lateral and crucial ligaments and to the tendinous expansion of the vasti. The deformity is sufficiently conspicuous to be recognised at once, the internal condyle of the femur resting on the outer tuberosity of the tibia (or *vice versâ*) and forming a distinct and easily recognised projection on the side. Reduction, owing to the extent of the injury, is easily accomplished by flexion and extension combined with lateral pressure. Afterwards the knee must be placed upon a splint, raised, very carefully bandaged and covered with ice. Passive motion may be commenced in a fortnight or three weeks, but through a very small angle, so as not to throw any strain upon the ruptured parts; and the patient should not be allowed to bend the joint himself for at least a month more. Afterwards an apparatus must be worn restricting the movement of the joint, for fear of any sudden twist displacing the bones again.

Antero-posterior dislocation.—Dislocation of the knee forwards may take place either by over-extension or by direct violence: dislocation backwards, which is much more rare, only by the latter. The luxation may be complete, the tibia being carried altogether in front or behind the femur, and forced some distance up the thigh; or more often incomplete, and the bones still to a great extent in contact. The ligaments are always torn, or wrench away portions of the bones; the neighbouring tendons and muscles, such as the hamstrings and the gastrocnemius, are lacerated or stretched; and the vessels either compressed, so that the circulation is stopped, or actually torn across. The shape of the bones is easily made out, and the nature of the injury can hardly be mistaken. In the forward dislocation the limb is usually extended, and if it is complete, much shortened. The patella is freely movable; sometimes the joint is fixed; sometimes, owing to the extent of the laceration and the position of the bones, there is a wide range of passive movement. In the backward form the displacement is more variable; generally the limb is in a position of extreme extension, but it may be completely flexed.

Reduction, especially under an anæsthetic, is easy, and may be accomplished either by traction in the axis of the limb, or by flexion and extension, according to the position of the bones. The condition of the vessels below should be ascertained at once; even if the artery has only been compressed or stretched, a thrombus may form, and gangrene set in; or later an aneurysm may develop; if it has given way, immediate amputation should be performed. Usually this is required in compound dislocations; only, perhaps, sometimes, when the skin is not so much torn, and the vessels are intact, and the patient is young and healthy, an attempt may be made to save the limb, either by washing the joint out and draining it thoroughly, or by performing a primary excision.

Dislocation of the Semilunar Cartilages

In this accident, which was first described by Hey under the name of *internal derangement of the knee-joint*, one of the semilunar cartilages is displaced and caught between the bones, so that the joint is locked and, so far as the patient is concerned, is entirely out of control.

The external cartilage glides backwards and forwards freely over the upper surface of the tuberosity; the internal is more fixed and follows the movements of the tibia; but the latter appears to be the more frequently displaced. The nature of the injury probably differs a good deal. Sometimes the margin of the cartilage is detached, and the disc is rolled inwards towards the centre of the joint; the external has been found by Godlee rolled up in the inter-condyloid notch. More often one of the ends is torn away from the bone, and the disc is squeezed out under the skin, either in front or to one side. The anterior part of the internal is the part that gives way the most frequently; and it has been found, as the result of football, so completely detached that it had to be removed as a foreign body. In many instances it is probable that the actual laceration is insignificant, the fibrous tissue by which they are attached being stretched, rather than torn, so that in certain positions of the joint the cartilages can be pushed backwards or forwards until they are caught between the bones. Such an accident may occur even in a healthy joint; but it is much more likely to happen when the ligaments are already relaxed by chronic synovitis or rheumatoid arthritis; and, for this reason, recurrence of the displacement, when once it has occurred, is the rule rather than the exception. The joint always becomes filled with fluid after this accident; the ends of the cartilage if it is torn, are forced apart from each other, so that repair can only be carried out imperfectly, and all the ligaments are stretched and softened. For the same reason internal derangement is not uncommon in young rapidly growing subjects, in whom, owing to the weakness of the muscles and the poor development of the articular ends, the bones can often be made to assume abnormal positions; but it may happen to the strongest and most athletic.

The cause is always a trivial one: crossing the legs, for example, while seated; catching the inner side of the great toe in walking; twisting round to take a ball at lawn-tennis; or even suddenly turning over in bed. Nearly always it is caused by rotation while the leg is semi-flexed; in eversion the internal one suffers; in inversion, the external; it may occur, however, at the end of extension, if there is no weight on the limb to hold the bones together. Thus it is common at football when a kick is missed: the posterior end of the internal cartilage is carried forwards until it slips under the condyle; if it slips back again, there is merely a sharp stab of pain, often followed by a slight amount of effusion; but, if it is caught, there is genuine displacement and the limb becomes locked. Knott's and some of Hey's cases were probably similar. In Lucas's the external was displaced, the posterior end being carried forward in the same way until it was caught under the condyle; there was a sudden jerk when the joint was flexed; a projection made its appearance on the outer side of the patella and the limb became inverted; in extension this was reversed, the limb becoming straight and the projection vanishing. Several similar instances have been recorded by Marsh.

It is not uncommon to find, after repeated accidents of this kind, that there is a certain amount of permanent thickening, generally on the inner side of the limb; and in one or two cases the disc appears to have become hypertrophied, from the effect of constant irritation. According to Kocher it may become converted into a mass of granulation-tissue, and, unless it is excised, lead to suppuration in the joint.

Symptoms.—In all the cases there is a strong family likeness, though there are many small points of difference, depending in all probability on the character and the direction of the displacement. There is a sudden attack of the most intense pain; the patient falls down almost in a fainting condition with the knee slightly bent; and in severe cases he is quite unable to stand. Voluntary movement is out of the question, but passive motion is free and almost painless; if the patient sits on a table he can swing the leg backwards and forwards, but not to its full extent in either direction. In a few minutes the joint becomes filled with fluid; by degrees the severity of the pain abates, and very slowly power returns until the patient can limp about; but so long as the displacement persists, full flexion and extension are impossible. Sometimes a projection can be seen on the outer or the inner side of the limb, corresponding to one of the cartilages; occasionally the skin is puckered in when the displacement is towards the interior; in most instances the only change visible is a slight relaxation of the ligamentum patellæ when compared with the opposite side. Synovitis is invariable and as a rule very rapid.

Slighter cases, in which the cartilage probably slips back of itself, are not uncommon. The patient generally complains of the joint locking or catching, of a moment's sudden pain, and then, after a sensation of something slipping away, of being able to move again, but with a certain degree of uneasiness.

Diagnosis.—The history and symptoms closely resemble those of loose cartilages in a joint, but the presence of a projection or a depression on a level with the head of the tibia, and the continual locking of the joint, generally make the diagnosis certain. If, however, before the case is seen the synovial cavity has already become distended, the difficulty may be very considerable, and in all cases in which the history, or symptoms, suggest either of these conditions, it is advisable to make the most thorough examination, not only at once, but afterwards when the effusion has in great measure subsided. Much discredit has arisen on more than one occasion from the fact that this displacement has never been recognised.

Treatment.—The first thing is to release the cartilage. In the slighter cases it often slips back of itself before the patient is seen, or is reduced by some almost involuntary action. Knott, for example, relates how, on the first occasion on which it happened to himself, he instinctively applied his hands upon each side of the joint and pressed as firmly as he could to relieve the pain; suddenly he felt something slip and the limb could be moved again at once. Where the displacement has repeatedly occurred this is frequently the case, and the patients learn either to do it for themselves or to direct others in the manipulation required. An anæsthetic is not absolutely needed, but in most cases it is advisable: the manipulation is so much more easy, and the condition of the joint can be examined so much more thoroughly.

Hey recommended that the patient should be seated on a high chair facing the surgeon, who should grasp the limb firmly, extend it, until it was as straight as circumstances would allow, and then rapidly flex it. Modern surgeons have reversed this proceeding with advantage, as preliminary extension is much more painful than flexion, and in the second step rapid flexion is somewhat difficult to carry out. Whichever plan is adopted, firm pressure must be made with the thumb over any projection that can be felt. If this fails the limb may be flexed to its full extent, rotated inwards or outwards as far as it can be, and then rapidly extended, or abduction and adduction may be tried in the same way. Sometimes it suddenly slips into position almost of itself; in a few cases it has never been reduced at all, although repeated attempts have been made, not only at first, but afterwards, when the effusion into the joint had been absorbed. In such cases, or if the displacement takes place so frequently that the joint is practically useless, and is in serious danger of becoming disorganised from repeated attacks of synovitis, there is no doubt the cartilage should either be removed, or be reduced and stitched into position with catgut.

As soon as reduction has been accomplished, means must be taken to get rid of the effusion. Recurrence cannot always be prevented, especially if one end of the cartilage has been torn off the bone; but there is no doubt the tendency to it is greatly increased by the amount and persistence of the effusion. The limb must be carefully packed in cotton-wool and bandaged as firmly as possible; and if the pain and tension are very severe, it should be placed upon a splint and the patient kept in the recumbent position for a few days. Passive motion may be commenced after forty-eight hours, so that there may be no after-stiffness or wasting of the muscles; but the extremes of flexion and extension should be avoided, and care should be taken to keep the foot perfectly straight.

After the effusion has been absorbed an apparatus must be worn for some months, especially when indulging in any exertion which, like lawn-tennis, has a particular tendency to produce this displacement. If it has happened only once, an elastic knee-cap, strengthened and padded opposite the cartilage, whichever it is, may suffice, but this must only be worn during exercise, never at night ; and the knee, every time it is removed, must be thoroughly rubbed and shampooed, or more harm than good may result. In older cases this is not enough, and a metal apparatus must be fitted on. A very good arrangement consists of two well-padded metal plates, accurately fitted round the knee-cap, one on either side, and held together above and below by short straps. These plates are connected together by a steel spring passing horizontally across behind the joint, so that when the splint is in position they press firmly upon the unprotected portion of the capsule where the displacement is most likely to take place. If this does not answer, or if, as not unfrequently happens when the internal lateral ligament of the knee-joint has been injured, rotation of the tibia is a marked feature in the displacement, the best kind of apparatus is formed on the principle of two lateral bars, jointed opposite the knee and connected together above and below by a circle round the limb, formed partly of metal, partly of leather. An additional strap across the joint above and below the patella is of service. This is heavier and more cumbersome, but much more efficient than the former in checking irregular movements of rotation. In any case the patient should learn to keep the foot as constantly as possible turned in the direction of the displacement—inverted, that is to say, when the internal cartilage is affected, and *vice versâ*.

DISLOCATION OF THE ANKLE

The foot may be detached from the tibia and fibula, and driven either backwards, forwards, inwards or outwards ; but the displacement is rarely complete. A few cases are recorded in which the bones of the leg have been separated from each other, and the astragalus driven up between them.

Lateral Dislocation

This is caused by the foot being forcibly twisted on an antero-posterior axis, and it can scarcely take place without fracture of one or both malleoli.

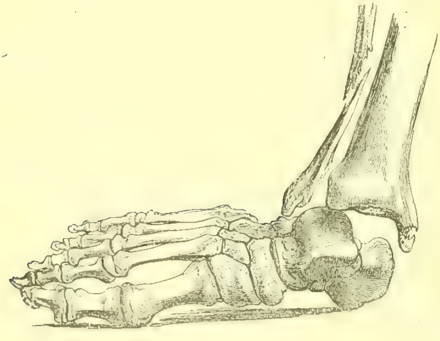


Fig. 218.—Pott's fracture.

Dislocation outwards, with fracture of the fibula, is the more common, and is known as Pott's fracture (fig. 218): the foot is forcibly everted, the strain falls upon the internal lateral ligament or the internal malleolus ; one or other of them gives way, the fibula breaks inwards towards the tibia a short distance above the joint, and, if the force continues, the astragalus is twisted round in its socket, carrying with it the bones of the foot. When the violence is very great, there is, in addition, a vertical fracture through the tibia, a portion of the bone being dragged away by the interosseous ligament. If the separation is only slight, the deformity is not serious, though, unless care is taken to prevent it, the socket in which the astragalus is fixed may be widened, and the security of the joint permanently impaired; but, if it is extensive, the whole of the foot and the external malleolus may be carried upwards on to the outer side of the leg, until the articular surfaces are completely displaced. This, which is known as Dupuytren's fracture, is very rare but very serious.

It sometimes happens when both malleoli have given way, that the astragalus with the foot is carried bodily outwards or inwards on the leg without any twisting.

Dislocation inwards is not so often met with. It can only be produced by extreme inversion; the internal malleolus or the portion of the tibia carrying it, is prised off by the rotation of the foot, and either the external lateral ligament is torn, or, more commonly, the fibula is broken outwards from the traction upon its inferior extremity. Sometimes the astragalus itself is crushed as well.

ANTERO-POSTERIOR DISLOCATION

In spite of the width of the astragalus in front, and the strength of the lateral ligaments, the foot is occasionally displaced backwards; displacement forwards is very rare. In either case the lateral ligaments give way; or the fibula, or the internal malleolus, is broken off instead, and carried forwards or backwards with the bones of the foot.

Dislocation backwards may be either complete or incomplete (fig. 219). It is caused by forced plantar flexion, the point of the foot being depressed until either the bones or the anterior part of the lateral ligaments give way; then if any force is applied to the leg from behind (such, for example, as the impetus of the body in falling from a carriage in motion) the tibia and fibula are driven over the front of the astragalus. As soon as the force is spent, the foot is straightened by the action of the muscles.

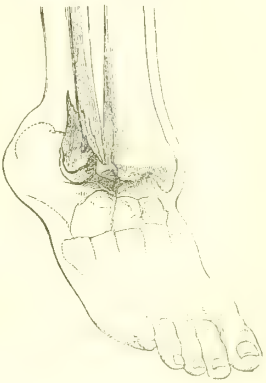


FIG. 219.—Dislocation of foot, backwards.

Forward displacement may be produced by extreme dorsal flexion: if, for example, while the foot is fixed and the knee and ankle are completely bent, a violent blow is delivered on the front of the thigh, driving the bones of the leg backwards; but only six cases are on record.

In *dislocation upwards* the fibula is wrenched off from the tibia, the interosseous ligament either giving way or tearing off a portion of the bone; the lateral ligaments are torn, and the astragalus is forced vertically upwards into the interspace. This can only arise from an extreme degree of violence applied to the sole of the foot, the bones first being separated and then the astragalus driven upwards by a continuance of the force. In one case it was bilateral, caused by jumping down from some great height.

Diagnosis.—Immediately after the accident, there is rarely any difficulty, owing to the way in which the bony prominences stand out beneath the skin; but the outlines soon become fainter as the depressions are filled up by the extravasation and swelling, and, in a little while, nothing can be seen but general distortion. The position of the foot with regard to the rest of the limb, whether it is inverted or everted, shortened or lengthened, always gives a clue to the nature of the injury; and then deep pressure may be used to determine the particular character of the displacement and the amount of damage done to the bones and ligaments, every bony projection being compared, one by one, with the corresponding ones in the opposite foot. Finally, passive motion must be tried, not only to assist in identifying the bones by the way in which they move, but to ascertain the presence of abnormal mobility (lateral flexion, for example), or of crepitus.

Treatment.—The method of reduction is essentially the same in them all. The patient must be placed under an anæsthetic, to relax the muscles; the knee must be flexed, and then the foot must be slowly but firmly brought round to its right position. If the displacement is lateral, this is generally easy; when it is backwards, it may usually be managed by extreme plantar flexion, drawing the foot downwards, away from the leg, at the same time, and rocking it from side to side so as to disentangle it; but in dislocation of the foot forwards the difficulty is very great. Dorsal flexion appears to offer the best prospect, and the tendo Achillis, or any other that gets in the way between the bones, may be divided; but even then the attempt has not always been successful.

Upward dislocation, the diagnosis of which is easy, from the enormous breadth of the lower part of the leg and the approximation of the sole to the malleoli, can only be reduced by extension on the foot. If the attempt fails, the limb ultimately becomes very useful, although the joint itself always remains stiff.

In all dislocations of the ankle, some form of apparatus is required after reduction has been accomplished, to prevent the surfaces being displaced again. In the slighter cases, in which the tendency to return is not very marked, and the injury is seen a short time after the accident, so that the extravasation is not extreme or the skin in danger of giving way, a fixed apparatus may be applied at once, only it must be formed in two parts, laced or fastened together in some other way; and it must be thickly padded with cotton-wool opposite the seat of injury. Afterwards the limb must be raised for twenty-four hours, and the knee-joint kept flexed until the tendency to spasmodic contraction on the part of the muscles has disappeared. Passive motion and massage may be commenced at the end of ten days, but the limb in the meantime must be encased in a starch bandage, and the patient must not be allowed to rest any weight upon it for at least six weeks. The greatest care is necessary during the whole course of treatment to prevent any drooping of the toes or version of the foot. If either of these is present, the limb becomes almost useless.

When the injury is more severe, and in all cases of antero-posterior displacement, it is better to make use either of back and side splints, swinging the leg from a cradle (as already described in speaking of fractures), or of a single side splint with a foot and sole piece, the limb resting upon its outer surface. In either case the knee must be kept well bent, the foot must be exactly at right angles to the leg, and the pads must be so arranged on the splints as to correct as far as possible any tendency to eversion or inversion. If a side splint is used, it is of great advantage to pack the ankle well with several layers of cotton-wool, and bandage it firmly over all. Very often, unless this is done, it is difficult to be certain whether the displacement is rectified or not, owing to the amount and the persistence of the œdema and extravasation. The limb may be placed in a fixed apparatus at the end of a fortnight, but this must be so arranged that it can be removed for the purpose of carrying out passive exercise every two or three days. If this is neglected, the joint is liable to become exceedingly stiff and painful.

Compound dislocation of the ankle-joint is a most serious injury, and, especially if the patient is broken down in health, may require immediate amputation. Age is not of so much importance in this respect as the condition of the kidneys, though of course the risk increases with advancing years. Much depends upon the way in which the accident happens. If it is the result of indirect violence, so that the skin on one side of the joint is torn, and the interior exposed, without the bones being crushed or the soft parts bruised, the limb may be saved, though it can only be done by the most perfect drainage. Even if suppuration and anchylosis occur, it may prove exceedingly useful, the mid-tarsal joint replacing the one that is lost. The bleeding must be stopped; detached fragments of bone or cartilage removed; the wound thoroughly washed out (it is a very good plan to immerse the part bodily in a corrosive sublimate bath for some hours) and so arranged that it can drain perfectly, counter-openings being made, if need be, to ensure this. If the wound is very small, it may be sealed and closed at once: as a rule, it is better to leave it open, so that the cavity can be constantly washed out and there may be no accumulation in the interior. Then the ankle must be covered with a thoroughly absorbent dressing and fixed upon a splint, interrupted so that the wound may be exposed without disturbing the bandages. Paraffin is very useful for this, as it is waterproof.

In many cases the wound heals up at once: sometimes there is a certain amount of discharge; granulations spring up round the orifice, the synovial lining becomes unduly thickened and vascular, and the joint is stiffened from the formation of extra-articular adhesions; but the cartilages remain intact and the cavity is preserved. If, however, the drainage is not perfect, or if the discharge is allowed to decompose inside, acute suppurative arthritis is sure to set in; the cartilages necrose; the ligaments are destroyed; the surface of the bones becomes carious; and abscesses form in the loose cellular tissue around. Even then, if free exit is provided, and the cavity is kept constantly clear, granulations may spring up and fill the cavity, until the opposite surfaces fuse together; but secondary amputation may at any moment become necessary. The patient's health and strength may fail from the intensity of the fever and the profuse suppuration; or the inflammation may spread along the tendon-sheaths or the planes of cellular tissue; or the bones may become extensively necrosed; and, finally, even when anchylosis has set in, it may be required, owing to the useless condition of the limb.

When the injury is more severe, the same general plan of treatment may be followed; but if it is the result of direct violence the prospect of success is very small. The tendons may be sutured; the ends of the bones resected (removal of one malleolus has some advantage, as it gives more room for drainage), and even the posterior tibial has been divided and tied, with a good result; but if the skin is badly bruised and stripped off the subjacent tissues, or if it is torn a considerable way round the limb, recovery with a useful foot is almost hopeless.

DISLOCATION OF THE ASTRAGALUS

This must be distinguished, on the one hand, from dislocation at the ankle-joint, in which the whole foot is detached from the leg; and, on the other, from the subastragalar form, in which the rest of the tarsus is separated from the astragalus. In this injury the astragalus is dislocated both from the foot and from the leg; and is thrown out from its socket, sometimes so thoroughly that it has been shot out of the foot altogether.

The displacement may be either forwards or backwards, the bone generally being forced to one side or the other at the same time. True lateral displacement without fracture of the malleoli is scarcely possible; most of the instances, in all probability, having been really dislocations forward first. In a few very rare cases the astragalus has undergone a process of version without leaving its bed; the bone has been twisted round in its socket by some violent wrench, so that the lateral surfaces look upwards or downwards, or its head faces one of the malleoli.

Dislocation forwards is produced by over-extension; the foot is first detached from the astragalus; the head of this bone is twisted out from the scaphoid; and then, if the force continues, the lateral ligaments give way, and it is shot out from underneath the tibia. As soon as the force is spent the muscles pull the foot into position again. The dislocation may be either complete or incomplete: the astragalus, that is to say, may be forced altogether out of its socket, until it rests either on the cuboid, or on the scaphoid and cuneiform bones, according to the side, while the tibia rests upon the os calcis: or it may be merely detached from its connection, and lie still partly under the bones of the leg (fig. 220). In either case the neck of the bone is not unfrequently broken.

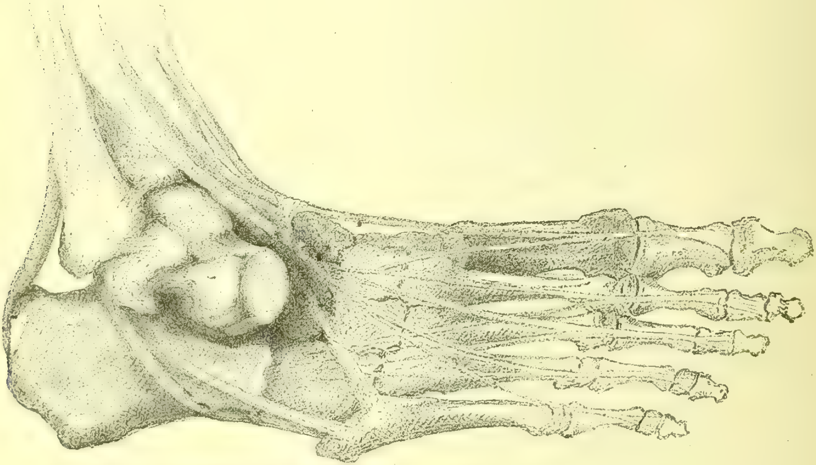


Fig. 220.—Subastragalar dislocation, with partial luxation of astragalus from leg.

The prominence caused by the peculiar shape of the bone can be recognised at once: the foot is turned inwards or outwards, in the opposite direction to the displacement; the sole, especially in the complete form, is brought nearer to the leg; one malleolus stands out while the other is deeply sunken; and all movement is abolished.

Dislocation backwards is much more rare, and, owing to the space in front of the tendo Achillis, is not so conspicuous. It can only be produced by extreme flexion; in one instance, for example, the foot was fixed, the heel driven down into a depression, and the leg crushed down upon the foot. In most it is incomplete, and generally it is rather to one side, but it may be nearly straight. The foot is neither inverted nor everted; in front there is a depression over which the edge of the tibia can be felt, and the great toe is strongly flexed, owing to the tension on the tendon of the flexor longus pollicis; behind, the tendo Achillis is forced back, a hardness can be felt in front of it, and in some cases, where the displacement is lateral, the shape of the bone can be made out to one side or the other.

Treatment.—In the incomplete form of dislocation forwards (which is the most common) reduction may be accomplished by placing the patient under an anæsthetic, bending the knee, and making traction on the foot away from the leg while in the position of plantar flexion, direct pressure meantime being exerted on the anterior surface of the bone. If this fails the tendo Achillis may be divided, and any other bands that are plainly in the way; but, especially if the dislocation is complete, the attempt is very likely to fail. The space between the bones is so much reduced; the astragalus itself is often twisted; there is very little hold; and sometimes the bone is so caught and entangled that it cannot be released.

If it does fail, the astragalus should be left *in situ*; the foot, especially when the dislocation is backwards, regains a wonderful amount of power. Subsequently, if the skin over it sloughs, or if it is seriously in the way, it may be excised. The operation should not be performed at once, as the parts are so badly bruised that suppuration would almost certainly occur.

In compound dislocations, if the skin and the vessels are not much injured, the astragalus may be freed from its remaining attachments and excised; but in many cases amputation is necessary.

Subastragalar Dislocation

This is produced in the same way as the former, but by a less degree of force; the bones of the tarsus only are separated from the astragalus; this is often partially displaced from under the tibial arch, but is not dislocated from it (fig. 220).

Dislocations forwards, and to one side, have been described, but the displacement is nearly always backwards, with a certain amount of lateral deviation. It is generally complete so far as the scaphoid is concerned, but it is seldom that the astragalus is entirely detached from the os calcis. The foot is in the position of plantar flexion, everted or inverted, in the direction of the displacement, and carried backwards. The head of the astragalus forms a rounded projection on the dorsum under the skin; one malleolus is prominent, the other buried; but they still retain their relation to the astragalus; there is no shortening, as in the former dislocation, and a certain amount of movement is permitted at the ankle-joint itself.

Reduction may be accomplished by drawing the foot forwards, while in extreme plantar flexion, and pressing from behind upon the heel. If this does not succeed, any tendon that is clearly in the way may be divided, and a further attempt made : but not unfrequently it fails, either because the under surface of the astragalus is caught against the groove of the os calcis or the dorsum of the scaphoid, or because the neck of the bone is entangled in the tibial tendons.

Dislocations of the other tarsal bones are very rare : the internal cuneiform and the scaphoid have been displaced separately ; and the scaphoid and cuboid, carrying with them the anterior part of the foot, together. There are more instances known in which the metatarsus has been dislocated from the tarsus ; sometimes all the bones together (in one case carrying with them the internal cuneiform) ; more often separately or in groups of two or three.

Dislocations of the toes, both at the metatarsal and phalangeal articulations, are not uncommon ; in the case of the great toe the same difficulty occurs as that already described in the thumb, probably for the same reason.

Section V.—Diseases of Joints

Inflammation of a joint nearly always begins in the most vascular part, that is to say, either the synovial membrane or the growing portion of the bone, and spreads from there to the rest of the tissues. Osteo-arthritis is an exception ; whether it is acute or chronic, inflammatory or degenerative, it is general from the first, and affects all the structures, though not always to the same extent.

Pathology

1. *The synovial membrane and the capsule.*—The immediate effect is the same, whether the inflammation begins in the cavity or extends into it from the bones or other structures near.

The vessels dilate ; the amount of blood flowing through the part increases ; lymph is poured out in excess ; the cellular tissue becomes soft and spongy ; the interstitial spaces are enlarged and filled with exudation ; the endothelium is detached ; and the interior loses its polished appearance, and becomes rough, velvety, and granular. In severe cases stasis and extravasations of blood occur as well. This is most marked where the tissues are soft and vascular : the fibrous capsule at first is scarcely affected ; on the other hand, the folds at the margins of the joint, and the pads of loose cellular tissue and fat which fill up the inequalities between the bones as the position of the limb changes, become more and more swollen, until the whole available space is occupied.

The exudation collects in the synovial cavity even more freely than it does in the tissues. The amount of fluid is increased ; the peculiar character of the synovia is lost ; and the joint is filled with a turbid and blood-stained fluid, mixed with detached endothelial cells, flakes of fibrin, small blood-clots, and masses of lymph-corpuscles.

The ligaments and the capsule, owing to the density of their structure and the scanty distribution of vessels, for a long time show but little change. If, however, the inflammation continues, at length they share the same fate: hyperæmia begins to show itself; the fibres soften; the interfibrillar substance becomes more abundant and more fluid; the exudation increases in amount; new vessels grow in from around; and by degrees the natural structure is replaced by a mass of soft vascular granulation-tissue, in which a few traces of the old bundles of fibres can be found here and there more or less softened.

The subsequent changes depend upon the nature and persistence of the cause.

If it ceases to act, resolution begins; the hyperæmia disappears; the exudation is absorbed; and the fibrous tissue becomes firm again.

If it continues, the effect depends upon whether it is (*a*) merely a mechanical or chemical irritant or (*b*) a living organism.

(*a*) In the first case the synovial membrane may continue to pour out an enormous quantity of a clear watery fluid (*hydrops articuli*); or a kind of false membrane may form upon the inner surface (*fibrinous synovitis*); or the secretion may grow thicker and thicker, until, without there being any destruction of the cartilages, or suppuration outside the joint, the interior is filled with a fluid apparently similar to pus (*purulent synovitis*); or (especially when it is due to rheumatism) organisation may be the prominent feature: the synovial lining becoming thickened and opaque; the soft tissues condensed and hard; and the interior covered with outgrowths, synovial folds and fringes, sometimes uniform in shape and size, and springing from every part of the sac (*papillary synovitis*) (fig. 228), sometimes few in number and very large.

(*b*) In the second, when the irritant is a living organism, the effect depends upon its mode of action. In tubercle, for example, the synovial membrane and the structures around are converted into a mass of granulation-tissue, which slowly undergoes caseation and liquefaction: in syphilis, gummata form; and when the micrococci of suppuration enter, all the tissues melt away and form pus; the whole joint is converted into an abscess, and, unless the tension is relieved at once, even the cartilage and the bone perish.

2. *The bone and cartilage.*—(*a*) If the irritant is a very intense one, the bone and cartilage, like other dense and almost non-vascular structures, simply undergo necrosis. Sometimes the sequestra are wedge-shaped (fig. 237), with their base towards the joint and covered with cartilage, as if caused by embolism. A mass of some material (caseous and full of bacilli if it is tubercular; broken-down blood-clot with micrococci in pyæmia) is carried along by the blood-stream until it is impacted in one of the small arteries at the cancellous end of a long bone; and the corresponding area of tissue perishes, partly from the blood-supply being cut off, partly from the inflammation caused by the embolus. Sometimes, on the other hand, when the attack starts from the synovial cavity, the surface is the first part to feel the effect, and either the whole of the cartilage is separated from the bone beneath (fig. 223), or, more frequently, only those parts upon which the pressure falls, where for example the patella and the upper surface of the tibia are in contact with the condyles of the femur. When this occurs the articular lamella of

the bone usually comes away as well, leaving the cancellous tissue beneath exposed and carious.

(*b*) If the exciting cause is not sufficiently intense to cause necrosis, the bone and cartilage undergo the same changes as the other tissues, only more slowly and with certain peculiarities of their own.

In the bone, the inflammation begins as rarefying ostitis: the cancellous tissue becomes softer and more vascular; the trabeculæ are absorbed; and the cancelli filled with inflammatory exudation. What happens next depends upon the exciting cause. Resolution takes place in a large proportion of cases. Of the rest, in some the exudation simply continues to spread (fungating caries), without undergoing any further change, until it invades the articular lamella (fig. 236), and either detaches the cartilage from beneath or perforates it; in others it breaks down into pus, and bursts through everything into the synovial cavity; and in others again it undergoes organisation and leads to sclerosis and condensation (fig. 227).

The effect on the cartilage is very similar. The matrix becomes softened (in osteo-arthritis it splits up into fibrils arranged vertically to the surface (fig. 224)); the plasmatic canals dilate so as to allow the entry of a larger quantity of lymph; and the corpuscles increase in number. In the centre, where there is pressure, the inflamed cartilage becomes absorbed; around the margins it becomes vascular, the blood-vessels growing into it from the synovial membrane, so that it is either gradually replaced by granulation-tissue, as in tubercular disease, or is heaped up into thickened and hypertrophied lips, as in osteo-arthritis. So slowly, however, does this take place that, in many forms of joint disease, the cartilage is removed by simple atrophy and fatty degeneration, or by the erosion of granulations that spring from the opposite bone or the surrounding tissues. In the former case the whole covering of cartilage is thinned; the surface is smooth and rounded for the most part, but marked here and there with broad flat depressions, where the pressure of the opposing surface has caused absorption to progress more rapidly, and the microscopic character is unaltered except for the presence of fatty molecules in some of the corpuscles. In the latter it is eaten out all over into little circular pits, some quite superficial, others so deep that the bone beneath is exposed (fig. 221).

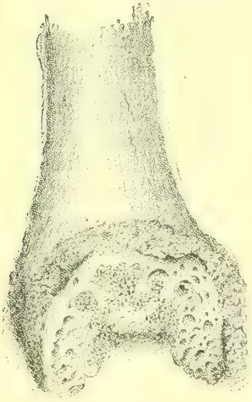


Fig. 221.—Lower end of femur of an infant, from a case of suppurative arthritis, showing the way in which the cartilage is eaten out in little circular pits, some penetrating down to the bone.

Etiology

Inflammation of joints may be primary, originating in the synovial lining or some other component part; or consecutive, due to extension from a focus of disease in other structures near.

1. *Primary inflammation* is due either to the persistent action of a mechanical or chemical irritant, or to a living organism.

(*a*) *Mechanical injury.* A single strain merely causes a certain degree of damage, which, if the tissues are healthy, is repaired forthwith. If, however, it is repeated, or if before its effects have died away a second irritant of any description makes its appearance, nutrition is impaired and inflammation follows. Thus a neglected loose cartilage gives rise to synovitis and ultimately arthritis; and want of rest or undue tension may cause an acute attack after a simple sprain.

(*b*) *Chemical irritants.*—In gouty synovitis, urate of soda is always present in the fluid and sometimes in the tissues. It may be itself the exciting cause; but, as it is not unusual to find a considerable deposit in joints that have never shown a sign of inflammation, it may, on the other hand, merely be an evidence that the vitality of the tissues is impaired, so that they are unable to withstand the slightest irritation. Of all chemical poisons, the most intense is that produced by septic decomposition, breaking out in a foul and ill-drained wound.

(*c*) *Living organisms.*—These may be pyogenic or specific. In either case the irritated tissues around strive to protect themselves and repair the injury by throwing out masses of lymph; in the former (acute suppurative arthritis) this melts away as pus, the fully developed tissues perishing too, so long as the germs are the stronger; in the latter, either caseation and liquefaction set in (tubercle) or absorption and organisation (syphilis).

In addition to these there are, as in the case of ostitis, other agencies which perhaps should rather be regarded as predisposing than exciting causes. Of these, the most important are the action of cold and damp and the influence of the central nervous system.

(*a*) Exposure to cold and damp may be followed either by acute inflammation (the resisting power of the tissues is so depressed that the least irritation is sufficient to cause a very severe attack); or when, without being intense at any one time, they exercise their influence for years together, by a kind of degeneration or very chronic inflammation, characterised by changes similar to those that occur in old age or after prolonged disuse, but more severe.

(*b*) *Diseases of the nervous system.*—It is believed by many that certain very rapid forms of degeneration, attended with more or less inflammation, may be caused by diseases of the central nervous system or the peripheral nerves. The pathological changes belong to the same class as those that follow prolonged exposure to cold and damp and other depressing agencies, though they present certain differences in degree; the clinical symptoms, however, in most cases enable a distinction to be drawn at once.[1]

How causes of this kind act is uncertain. It must be admitted, if they are merely predisposing ones, their influence is so strong that an almost imperceptible irritant is able to produce an entirely disproportionate result. All that can be said is that the impairment of nutrition, known as inflammation, may be induced either by continued irritation (mechanical or otherwise); or by a depressed condition of vital energy, general or local (exposure to cold and wet, and certain affections of the nervous system); or with much greater effect by both together.

2. *Consecutive inflammation* may extend into the joint from any of the tissues near: the bones the most frequently; the bursæ, tendon-sheaths, and cellular tissue less often. So long as the original focus of disease is at some distance, whatever its character may be, whether it is traumatic, tubercular, or suppurative, only the synovial membrane shows any effect, and the inflammation is not specific. A tubercular focus, for example, in the end of one of

the long bones merely causes synovitis so long as the bacilli are limited to the bone; and after evacuation of the caseous focus (if it can be cleared out without involving the joint), the secondary affection disappears of itself; but, if left, the micro-organisms are almost sure to work their way in at last, and then the inflammation of the joint becomes tubercular and specific. The same is true of the pyogenic and probably of all other organisms: simple inflammation precedes the specific and prepares the way for it.

Mode of Examination

Examination in a case of suspected joint-disease must be systematic and thorough, conducted with a definite object, taking care not to alarm the patient, and putting off to the last everything that might give pain. Children in particular are nervous and often exceedingly afraid of being hurt, and an incautious movement at the first may throw all the muscles around the articulation into a state of perfect rigidity, and obscure some of the most valuable signs. Unless it is wished to explore sinuses with a probe, or to ascertain the existence or the extent of fibrous adhesions, an anæsthetic is inadmissible, as many of the most important symptoms depend upon contraction of the muscles, which, of course, disappears at once.

The *history*, family as well as personal, and any evidence of a constitutional diathesis that may be present, must be carefully noted, and then the patient's own account of the commencement of the disease, the supposed cause, the time of its first appearance, the progress it has made, the kind, severity and locality of the pain, and whether it is made worse by any particular movement. In the case of the lower extremity, if the inflammation is not acute, the amount of impairment can be fairly well estimated by seeing the patient walk.

It is an absolute rule that the two sides of the body must be compared together under the same conditions.

Inspection and *measurement* come first. If it is the hip-joint, the patient should lie upon a firm couch with the legs parallel and the knees extended; for the shoulders he should be seated facing the light. The condition of the skin, whether it is reddened or not, the shape of the joint, the presence of any enlargement, the wasting of the limb, or of one particular muscle, and any malposition—abduction or adduction, flexion or displacement—can be detected at once. The difficulty is greatest in the case of the hip, as by arching the back and tilting the pelvis, an appearance of parallelism and extension is produced, while the reality is very different. These results can then be verified by measurement. The rod should be used to ascertain any alteration in length, a tape to take the circumference, and callipers, or the hand, which after a little practice can appreciate the most minute change, to make certain as to the difference in shape.

Further information may be obtained by *touch*, proceeding very carefully at first, as sometimes there is great tenderness on pressure. The enlargement may be hard and firm, like the bone upon which it rests; or soft and fluctuating if it is due to an effusion of fluid; or it may have a peculiar elastic resistance, as when the synovial membrane and the tissues around are converted into a pulpy gelatinous mass; or it may vary very greatly in consistence, especially if suppuration has occurred and the pus is working its way near the surface. The *temperature* may be ascertained in the same way with great exactness, taking care always to compare identical spots on the two limbs; the loss of muscular tone can be felt, even when no wasting can be detected with the eye; and the finger often finds out that some parts of the skin are unusually tender or œdematous.

Finally, when all this is clear, an attempt may be made to ascertain the *range of movement*, whether it is limited in any direction or attended with pain; if there is any grating, as of two bony surfaces rubbing against each other, or crepitation, as when the cartilages have lost their polish and the synovial fringes are enlarged and hardened; and whether there is any abnormal mobility and displacement or dislocation of the ends of the bones. Greater care than ever must be taken in investigating this, as the least rough movement, or even sometimes the approach of the hand, scares the muscles into activity, so that the joint is held perfectly rigid.

Such tests as jarring the heel or the knee in hip-disease, which depend solely upon the pain they cause, should never be employed, unless from other evidence it is practically certain that the joint is not inflamed.

INFLAMMATION OF THE SYNOVIAL LINING

1. Simple Acute Synovitis

In most cases, synovitis is merely a symptom of arthritis: and whatever the cause, unless the attack subsides at once, the inflammation is never really restricted to the lining membrane. Still, for the sake of convenience, and because the changes, although they are not absolutely confined to that structure, are very much more extensively shown by it than they are by the rest, it is usual to describe some forms at least as if the affection were a distinct one.

Causes.—These may be local or constitutional. Injury, extension from the bone or from some other structure near, or cold and wet, may cause it; or, on the other hand, it may be merely a sign of some constitutional ailment, such as gout or rheumatism. These varieties, however, as they are specific, must be described by themselves.

The *pathological appearances* of simple synovitis have been described already. The joint is distended with fluid, the endothelial lining is detached, the interior is roughened and has lost its polish, all the folds are bright red or purple with extravasations, and so swollen that they overlap the margins of the cartilages; and all the loose tissues round are softened, thickened, and filled with lymph. The fluid varies much in character. In cases of injury in which the hæmorrhage is often considerable and the swelling immediate, it may be almost pure blood (*hæmarthrosis*); more often it is a mixture of synovia, blood, and lymph in varying proportions. In many cases it is thin and watery, as if it were mixed with serum; not unfrequently, when the inflammation is severe and the tension high, the number of leucocytes and the amount of fibrin increase to such an extent that it becomes milky and even purulent. This is known as *catarrhal suppuration*: it may occur after injury, but it is much more common when, as in urethral rheumatism, the irritant is of greater intensity without being so severe as to cause suppuration. The distinguishing feature between it and true suppurative synovitis is the preservation of the synovial membrane; the secretion comes merely from the surface and does not involve the deeper strata.

Symptoms.—The *position* of the limb is characteristic. The affected joint is fixed rigidly by the muscles in the position of greatest ease. The hip is flexed, abducted and everted, the knee held at an angle of 140°, the ankle slightly extended, the arm hangs by the side, and the elbow and wrist are somewhat bent. As a rule, the patient can flex the limb further still, but complete extension is out of the question. Not only does it diminish the capacity of the sac and increase the pressure upon its inner surface, but, by the traction it exerts upon some parts of the inflamed and tender capsule, it makes the pain tenfold worse. Later, when arthritis sets in, and the bone and cartilage are involved, this position is exaggerated, and more serious displacement caused by the persistent contraction of the flexor muscles.

The shape assumed by the distended synovial sac is equally important. In acute traumatic synovitis it is often filled to its utmost, but the general outline is scarcely altered; there is little or no œdema of the cellular tissue around, as in some forms of inflammation, and the weaker parts have not had time to yield and stretch, as when the attack is more chronic.

In *the knee* the patella is pushed forward; the depressions on either side of it, extending down by the ligamentum patellæ, are filled up, so that the front of the joint is evenly convex; and the pouch under the quadriceps is distended, though it is not stretched upwards as in chronic synovitis. Fluctuation can be distinctly felt on either side of the knee-cap, the hands being placed across the joint, one above and one below, so that the synovial pouch is grasped between the fingers and the thumbs; and the patella itself can be made to float. This is the most valuable sign of all. If the synovial sac is full there is no difficulty: the limb must be gently extended and supported so as to relax the quadriceps, and then the bone can be pressed back at once against the articular surface of the femur. More care is required if the distension is only moderate: the upper part of the sac above the patella must be emptied by squeezing the fluid out of it into the lower space; and the pressure must be made directly upon the centre of the bone, not upon its lower end. If the quadriceps is relaxed and the patella drawn down, the lower end rests upon a soft cellular pad of fat, and even when there is only the normal amount of fluid in the joint the sensation of floating is easily produced if pressure is made on the apex.

In the *ankle* the chief swelling is behind, on either side, between the malleoli and the tendo Achillis, and in front lifting up the extensor tendons. In the *elbow* it lies on either side of the tendon of the triceps and over the head of the radius. In the *hip* and *shoulder* there is, on the other hand, only an ill-defined fulness—most marked in the former beneath Poupart's ligament, in Scarpa's triangle, and shown particularly when the limb is abducted, flexed and everted; in the latter, raising the whole of the deltoid.

Pain is always present: sometimes it is very severe and of a tense throbbing character; often it is worse at night, and always if an attempt is made to use the part or press the two bones together. The skin is freely movable over the deeper structures; there is no redness or œdema; but it is excessively tender, and at times even the weight of the bed-clothes can scarcely be borne. Usually there are certain spots, peculiar to each joint, much worse than the rest. On the inner side of the knee, for example, there is one on a level with the upper border of the articular surface of the tibia; in the hip it lies behind the trochanter; and in the ankle in front of the external malleolus. The *flexor muscles* are in a state of *tonic contraction*, so as to limit the amount of movement as much as possible; the *extensors*, on the other hand, *waste*, and, especially in the case of purulent synovitis and that form which ultimately merges into osteoarthritis, distinct flabbiness and loss of tone may be present by the end of a week. When the joint is superficial the *temperature of the skin is distinctly raised*; and, if it is large, or if several are involved together, slight chills are not uncommon with a certain degree of fever. In some of the constitutional forms of synovitis it may be very severe.

Course and termination.—The subsequent course depends partly upon the exciting cause, partly upon the condition of the patient.

In simple traumatic synovitis, the extravasated blood, if there is any quantity, coagulates in the interior; the hyperæmia and exudation continue to increase for a few hours, or perhaps two or three days, according to the severity of the injury and the success of the treatment, and then, if the part is kept at rest, resolution sets in. The coagula break down and liquefy; the blood-vessels contract again; the endothelial lining is restored; and the synovial fluid, though it remains coloured for some little time, gradually resumes its normal consistence. Occasionally, when there is a high degree of tension, or when the injury is repeated time after time, the inflammation becomes chronic, and either the synovial cavity remains distended or the walls become thick and rigid and covered over with fringes. Very rarely (unless there is an open wound) suppuration follows.

The same may be said of that form of acute synovitis which results from exposure to cold and wet; only, as the attack is rarely an isolated one, the tendency for the inflammation to become chronic is much greater. When, on the other hand, it is due to extension from neighbouring structures, or when it is a symptom of some constitutional disorder, whether it is tubercle, gonorrhœa, or one of the acute exanthemata, the termination is naturally dependent upon the exciting cause: it may subside without any further evidence of arthritis; or it may extend from one part to another until the whole joint is inflamed.

Treatment.—If there is an external wound, this must be dealt with first, according to its condition. Either it should be closed at once, sutures being used if required to draw the deeper parts together; or enlarged, explored, washed out and drained. The chief treatment must be local: the bowels should be well opened, and the diet light and unstimulating, especially if there is any tendency to gout or rheumatism; but, unless there is a high degree of fever or a well-marked diathesis, internal remedies are of little avail.

Rest is of the first importance. Every movement causes pain and makes the inflammation worse by increasing the amount of blood flowing through. Unless the attack is very slight, and affects one of the smaller joints only, the limb should be placed upon a splint, or fixed by means of a sling or a triangular bandage and raised. The position varies with each joint, and is not by any means that which the patient assumes of himself. The elbow should be flexed to a little less than a right angle; the hip should be straight, the knee bent ever so little, and the foot, in the case of the ankle, exactly perpendicular to the leg.

Heat, cold, and pressure are the most effectual means for checking the exudation and preventing tension. Of these, the first is limited in its application, and is chiefly of service in traumatic synovitis, when the joint, like the ankle, is superficial, and the limb can be plunged for a moment immediately after the accident into water as hot as can be borne. Cold is of more general use, and can be kept up for a longer time; but after the first few hours its utility diminishes very rapidly. The immediate effect is a contraction of the arterioles; but, if it is continued, the walls of the vessels lose their tone and passive congestion follows. A rubber bag, filled with ice, or Leiter's tubing with ice-cold water, is easily arranged in the case of most joints; or, if it is the lower limb, and the patient is confined to bed, lead and spirit may be allowed to drip from a vessel over the joint. Pressure, if it is properly applied, is by far the best. It must be perfectly uniform, falling on the soft parts as well as on the bones, gentle, and elastic, so that it does not slacken off as the blood-vessels become empty and the part diminishes in size. Absorbent cotton-wool answers all requirements. All the hollows of the limb should be packed with pads until the bones appear buried; then several thicknesses should be placed round the whole, and over all a moderately tight bandage. In the course of a few hours the extreme tension disappears and the bandage can be replaced by a firmer one. Nothing is equal to this for checking hyperæmia and exudation, causing the absorption of extravasated blood, and preventing the distension of the capsule, which is not only the chief cause of the pain (after the immediate effects of the accident have subsided), but, from the weakness it leaves behind it, a source of very grave inconvenience afterwards.

Pain, if it is very severe, may be relieved by placing a few leeches over the joint, or by giving a hypodermic injection of morphia. Aspiration is seldom required in cases of simple acute synovitis, though it may be advisable when there is a large extravasation into the synovial cavity, as in fracture of the patella, and it is of importance to empty the joint at once; or when, from the persistence of the swelling and the continued heat, there is reason to fear that the exudation is becoming purulent, Great care of course is necessary: the cannula should be cleaned by boiling in liquor potassæ, so as to make sure that no greasy substance is retained inside; and the opening should be valvular and well secured. Very often marked relief is obtained, even if only a few drachms are withdrawn: the tension is lowered; the pain and hyperæmia diminish; and absorption commences at once.

Passive motion should not be delayed too long. As a general rule, it should be commenced as soon as the temperature of the part is normal. Moving the joint once each day, through its whole range, quietly and steadily, cannot excite inflammation or cause severe pain, while it effectually prevents the formation of adhesions and contractions in the synovial wall.

2. Chronic Synovitis

Chronic synovitis occurs either by itself or as part of a general arthritis; but even when it is local at the first, the inflammation always involves the other tissues sooner or later. Sometimes it begins as such, quietly and insidiously; in most instances, however, it follows an acute attack, which, from want of rest or other causes, gradually becomes chronic.

The *pathological appearances* are very variable. The fluid is usually increased in quantity; sometimes there is an immense excess. Generally it is thinner and more watery than normal; sometimes it is almost serous, and straw-yellow in colour, and occasionally it is turbid; but it usually retains its lubricating feeling. The surface of the lining membrane is dull and opaque. In places it is rough and velvety; and around the margins where it is thrown into folds it may be covered with fringes and villous processes as thickly as in chronic osteo-arthritis. The fibrous capsule is softened and weakened at some parts; thickened and rigid from the organisation of the exudation at others. In some cases the weaker portions are stretched to such an extent that the shape of the sac is completely altered; hernial pouches form between the fasciculi, owing to the continued pressure; or the walls are gradually absorbed until a communication is established with neighbouring bursæ. In others the flexibility is lost; the soft cellular pads, which should yield at once to the pressure of the bones, are hard and dense; the delicate peri-synovial tissue is thickened and contracted; and the folds of the synovial membrane, especially where they are pressed together and kept at rest for any length of time, as on the inner side of the shoulder-joint, become adherent to each other, so that they cannot open out as the bones separate. In rarer cases the exudation in the interior becomes organised, and long slender adhesions are left, passing from one surface to another. They form during the acute stage of the inflammation, while the endothelium is detached and the walls are covered with lymph; and while still soft they are gradually stretched by some change in the position of the joint.

Symptoms.—The signs of inflammation are much less marked than in the acute form; the temperature of the part, for example, is scarcely raised, the pain is not so severe, and there is no constitutional disturbance; but there is evidence of much greater changes in the tissues: the muscles, especially the extensors, are atrophied; the outline of the joint is altered; sometimes the bones stand out too prominently, from the wasting of all the tissues over them, more often they are concealed by the distension of the synovial cavity. The shape of the synovial sac is not the same: the weaker parts of the capsule yield more than the rest; the pouch under the quadriceps, for instance, in the case of the knee is enormously increased in size, while the tough fibrous capsule on either side of the patella is scarcely affected. The joint is stiff and weak, with a feeling of insecurity and helplessness: the range of movement is limited, full extension in particular being impossible. There is crackling or grating, as one surface moves upon the other; sometimes it is the soft silken crepitus of cartilage that has lost its polish, more frequently the rough sensation produced by the synovial fringes as they are squeezed between the capsule and the bone; and there is always tenderness on pressure, not only at the usual points, but at others where the capsule is thickened from the organisation of lymph, or where it has grown out into little pedunculated masses which are caught between the finger and the bone.

Prognosis.—In most instances, tubercular disease for example, the synovitis is merely part of a general arthritis, or is associated with some diathesis, and requires special description. Sometimes, however, it is local and exists by itself.

In the early stages, while the exudation is still cellular and to a great extent fluid, resolution is usually complete if the cause is removed. Later, when organisation has set in and the wall has undergone a definite alteration in structure, the prospect is not so favourable. When part of the capsule is hard and rigid, or incorporated with the tissues around, or when the folds are hypertrophied and covered over with fringes, recovery is rarely perfect; the joint never moves easily, it remains weak and insecure; one spot in particular is painful, or one special action; the amount of fluid is too great, though it varies from time to time, and there is always the chance that a sudden strain, or the slipping of one of the pedunculated outgrowths between the bones, may give rise to an acute attack.

Treatment.—The sooner the exudation is absorbed the less the risk. If it is left for any time the capsule becomes stretched, and for want of proper tension the fluid collects again as soon as it is removed. Gentle uniform pressure—an elastic bandage, for example, over properly arranged pads—is most successful, especially in the early period, while there is still a certain degree of hyperæmia. As this disappears, friction and massage may be used for a few minutes each day to prevent the wasting of the tissues and increase the flow of lymph in the vessels. Then, as the fluid disappears, and only thickened bands and fringes are left, douching with a jet of warm water under moderate pressure, steaming, shampooing, and other more vigorous remedies may be tried. Very great relief is often obtained by the use of counter-irritants: oleate of mercury of various degrees of strength, with morphia, painted on the skin; iodine applied every day until there is very distinct tenderness; or, especially where there is an unusually sensitive spot, light flying blisters repeated at frequent intervals. Scott's dressing is invaluable when the fluid persistently re-collects. The joint is covered over with strips of lint, on which is spread camphorated mercurial ointment (an ounce of strong mercurial ointment to a drachm of camphor); over this are placed two or three layers of firm adhesive plaster; and then the whole is fixed and rendered secure by means of a starch bandage. This should be removed at the end of a week at the latest; by that time the strapping is too loose to exert any pressure, and very often a sufficient effect has been produced upon the skin. Not unfrequently it is advisable to vary the treatment, protecting the joint in the meanwhile from cold and overwork, without, unless the temperature is distinctly raised, laying it up completely.

In some cases, in which the effusion persistently returns again and again without any other sign of inflammation, aspiration and injection with a stimulating fluid may be tried. A one per cent. watery solution of carbolic acid or tincture of iodine and water (one part in ten) is usually employed. The fluid is injected into the joint, brought into contact as far as possible with all parts of the synovial cavity, and then allowed to escape again, the aperture being closed at once. The limb should be thoroughly packed with cotton-wool and kept upon a splint until the reaction that follows has subsided. Afterwards a certain amount of support (an elastic bandage for example) must be worn to prevent any further accumulation. This treatment, however, is by no means devoid of risk: the reaction may be very much greater than is wished, and it must not be forgotten that this passive collection of fluid (*hydrops articuli or hydrarthrosis*) is in many cases rather a sign of incipient osteoarthritis, or of that form of arthropathy associated with locomotor ataxy, than of simple chronic synovitis.

In others again the joint continues stiff and painful without any increase in the amount of fluid, and without any rise of temperature, every attempt at using it bringing back an acute attack, although the skin in the intervals is cold, blue, and congested. This may be due to the presence of bands or adhesions in the interior of the joint or in the loose tissue around the capsule; but much more frequently it arises from simple disuse and defective circulation. The appearance of the part is characteristic: it has a helpless, withered look about it, the skin does not fall into its natural folds, or move easily and freely over the prominences beneath; it seems as if it were shrunken on, and it is always cold, though the patient may complain of a constant burning pain. Movement is generally exceedingly limited and very painful, especially at one particular spot, and in many cases the least attempt at carrying it beyond a certain point is followed by a return of the acute symptoms. Such cases as these may generally be cured at once by massage, douching and friction; the circulation improves, the skin becomes warm again, and the synovial folds, which are as it were glued together from having been kept at rest too long while softened by inflammation, gradually open out and allow the proper movements to take place freely. Sometimes, however, this fails; instead of recovering, the joint continues tender, particularly at one spot; or, while other movements can be performed with ease, one remains impossible from the pain it causes. In this case it is probable that the synovitis is kept up by the stretching of an adhesion, and it may be brought to an end at once by suddenly rupturing it. The action and the spot must be noted carefully, the muscles thoroughly relaxed, preferably by an anæsthetic; the proximal segment fixed, and then the band torn across once for all by suitable manipulation. This condition, however, is much more rare than the former.

ARTHRITIS

Simple Inflammation

This may either begin in the synovial cavity and spread to the rest of the joint (primary), or follow disease of the articular ends of the bones or other adjacent structures (consecutive). It may be acute or chronic, and according to the nature and persistence of the cause it may subside or end in disorganisation. Suppuration is a complication and does not occur unless the vitality of the tissues is impaired and the pyogenic organisms gain entrance in sufficient numbers.

Causes.—Traumatic inflammation of the synovial lining is of common occurrence; but, except in the case of a neglected loose cartilage or frequently repeated sprains, it seldom happens that mere mechanical injury is sufficiently intense or prolonged to affect the other tissues of the joint. Chemical irritants either give rise to a specific form (gouty arthritis for instance), or, as in the case of septic decomposition, are so severe that suppuration follows almost as a matter of course. A typical example of simple inflammation is sometimes met with when there is a neighbouring focus of inflammation (consecutive arthritis); the knee-joint for instance may be slowly disorganised as a result of chronic ostitis of the lower end of the femur, without pus ever making its appearance in the articulation.

Pathological appearances.—The earliest changes take place in the most vascular parts. The synovial membrane is swollen, softened and reddened with extravasations; the cavity filled with a turbid blood-stained fluid, and the articular ends of the bones and the soft structures around deeply congested. The cartilages, as they contain no vessels, undergo no active change, and the same is true, although to a less extent, of the ligaments and capsule.

If the irritant continues, this becomes more marked. The amount of exudation increases: the fluid in the interior becomes thick, the ligaments soften, their fibres separate from each other, and all the interstices are filled with lymph.

The synovial membrane and the capsule are so swollen and thickened that they can scarcely be recognised. The cartilages lose their lustre and become opaque; they melt away on the surface and grow thinner and thinner, while around at the edges they are eaten out in little pits by the granulations that spring from the vascular circle around the bone; the periosteum is thicker than natural: it can be stripped off with ease from the surface beneath, and the bones themselves are deeply congested and so soft that they can be cut with a knife.

These extreme changes are only seen when the irritant is an intense one and suppuration impending. When the cause is a loose cartilage or a neighbouring focus of inflammation, they are much less marked; and as in these cases there is rather a succession of slight attacks at frequent intervals, than a single very severe one, at one time all the tissues may be swollen, softened and filled with exudation, at another they may be dense and hard from organisation and repair; but, inevitably, if the irritant is continued sufficiently long, all the tissues of the joint lose their natural texture and it becomes more or less crippled and anchylosed.

Repair.—The destruction may be arrested at any point: the irritant ceases to act, the hyperæmia subsides, and the exudation partly becomes absorbed, partly organised.

In most traumatic cases this takes place before the synovial membrane is destroyed, or any very serious changes are produced in the ligaments or cartilages; and then, although the capsule is left thickened and somewhat rigid, a very fair range of movement is regained. Even when the surface of the cartilage has been eaten away, and the ligaments softened, this is still possible, especially in children, so long as there is no displacement. The fibrous tissue that fills up the deficiency presents a sufficiently smooth and even surface, and the ligaments soon become firm again. If, however, the irritant persists (as in chronic osteomyelitis of the lower end of the femur when the sequestrum is locked in), the joint may become so rigid and painful that the patient is driven at last to seek relief in operation.

Symptoms and course.—Acute arthritis presents the same class of symptoms as acute synovitis, but they are very different in degree. The pain is more severe. The limb is flexed and held perfectly rigid. The skin feels burning hot, and, though it may be white at first and in the more chronic cases, reddened patches may show themselves over the part where the capsule is thin and superficial. The whole of the joint is swollen, not the synovial sac only; the shape is different: it is more rounded and uniform, spreading upwards and downwards over the bones, and not following the outline of the cavity. The consistence of the swelling is firmer; the tenderness on pressure is greater, and, though one or two spots may be worse than the rest, it is not confined to any part in particular. The extensor muscles waste even more quickly; the flexor ones maintain a state of rigid contraction, broken only by sharp spasms, especially at night, and the constitutional disturbance is much more severe.

These symptoms are followed by others which do not occur in synovitis. As the ligaments become soft and yield, undue mobility is allowed. *Displacement* of the articular ends and even *dislocation* may follow, the weight of the lower segment of the limb and the persistent spasm of the flexor muscles drawing the bones away from each other. *Friction* is felt when the joint is moved, owing to the cartilages having lost their smoothness of surface. At the same time, or even before this, peculiar *starting-pains* make their appearance. These rarely happen in the daytime or at night, when the patient is sound asleep; but, as he is losing consciousness and the muscles are relaxing their vigilance, there is a sudden violent jerk of the limb and the two bones are driven together with the most excruciating pain. This may happen time after time and night after night, until the patient dreads going to sleep, and keeps himself awake as long as he possibly can. It always means that the bones are inflamed, and often that the cartilages are eroded. The start is due to the sudden reflex contraction of the muscles. As they relax in sleep, one part of the joint moves ever so little upon the other, the stimulus is carried up to the nerve-centres, there is a sudden spasm in response, and the two bones are brought forcibly into contact. It is not uncommon for them to be present when no grating can be detected, either because the surface of the bone is covered with granulations, or because the cartilage is not yet removed.

If the irritant is very intense (such as the poison of septic decomposition) and the inflammation continues to spread, the periarticular tissues become involved, the skin becomes red and œdematous, especially along the inner side of the limb; the swelling increases rapidly in size and becomes more diffuse; the pain grows more severe and continuous; the constitutional disturbance becomes worse and worse, and at length the pyogenic organisms gain the upper hand and suppuration sets in, sometimes in the joint itself, sometimes in the tissues around.

Diagnosis.—Occasionally there is some difficulty in determining whether the inflammation involves the joint or some of the structures around it. This usually occurs in connection with bursæ (under the deltoid in the case of the shoulders, between the iliopsoas and the front part of the capsule in the hip; and in children under the crureus (between the quadriceps and the femur); but a careful examination nearly always settles the point at once. The shape of this swelling is different; movement in some direction is much more free than when the joint is involved, pain is less severe, and the constitutional symptoms are much less marked.

Treatment.—1. *Primary arthritis.*—(*a*) *Acute.*—In this, as in synovitis, local treatment is the most important. If the fever is high and the constitutional symptoms severe, small doses of aconite (one minim of the tincture), or of antimony, may be given at frequent intervals; the bowels must be kept open, the diet strictly limited, and antipyrin or quinine may be tried; but unless there is evidence of some definite diathesis, such as gout or rheumatism, constitutional remedies by themselves are of little avail.

Rest is the first consideration. Every movement of the joint not only causes intolerable pain, but makes the inflammation worse. At the very earliest sign, whether it is due to a wound or not, the limb should be placed upon a suitable splint. This varies of course with the nature and situation of the joint: it must fix both segments, the one above and the one below; it must hold the limb in the most convenient position, supposing it should become stiff; it must enable continuous extension to be made if it is required, and it must be arranged so that the cold, compression, or counter-irritation may be applied without its being necessary to move it. For the hip, either Bryant's or Thomas' splint may be used, according to the position of the joint, which is certain to be flexed, and which may not come straight for days; in the case of the knee, either Thomas' or McIntyre's. The anterior ones do not give sufficient immobility, or prevent the eversion which always takes place if the ligaments are softened and the limb is left to itself; but, both for this, the foot, and the joints of the upper extremity, nothing answers better than one of the various forms of plaster splints (especially Gamgee's absorbent cotton-wool dipped in plaster cream) or poroplastic felt.

Extension is part of rest, and, especially in the case of the hip and knee, is almost indispensable. It prevents muscular spasm and stops the starting-pains at once and in a fashion which nothing else can; it prevents the two bones being jammed against each other, and saves the articular cartilage from absorption; it helps to steady the limb and bring it into the right line, and it checks the tendency to displacement. It is managed most easily by means of a weight attached to a stirrup, the amount being proportionate to the size of the limb.

Elevation, cold, and *compression* are invaluable for checking the hyperæmia and reducing the tension of the part. With regard to the first, Lister has shown that not only does the venous blood return more freely when a limb is raised, but that there is as well a contraction of the artery under the influence of the vasomotor nerves. Of cold it is unnecessary to say anything, the only point is that it must be continuous and not intermittent. Ice-bags may be placed over the joint, or Leiter's coils wound round it; or, what is perhaps more effectual when the affected joint is covered thickly up, an ice-bag may be laid along the main artery supplying the limb. It has been proved that this has a very decided influence upon the temperature of the parts below. Compression is even more important, but it must be carried out thoroughly and carefully, or it may make the congestion worse. The whole limb, from its extremity to well above the affected joint, must be evenly packed with layer upon layer of absorbent cotton-wool. On the outside of this longitudinal strips of torn mill-board soaked in plaster cream are placed to give firmness and resistance; and then over all a bandage carried evenly upwards, diminishing the pressure ever so little towards the end.

Other remedies are occasionally of service. If the inflammation is very acute, ten or a dozen leeches may be placed over the joint. The skin may be covered over with a mixture of equal parts of extract of belladonna and glycerine. Morphia may be given hypodermically to relieve the pain and restlessness and procure sleep; and if the joint is very much distended, aspiration may be used to draw off some of the fluid.

(*b*) *Chronic.*—If this treatment is successful, the severity of the symptoms diminishes, the fever subsides, the hyperæmia disappears, and the exudation is in great measure absorbed. Very often, however, more or less organisation takes place, repair is incomplete, and a certain amount of chronic inflammation persists. The muscles are wasted; the joint is swollen and stiff; movement is painful; the temperature of the part continues higher than normal; there is tenderness on pressure; and every attempt at using the limb threatens to bring back an acute attack.

When this occurs rest is still essential; it must be rigidly enforced so long as the temperature is raised, although it may not be necessary to confine the patient absolutely to bed. With the aid of Thomas' splints and a patten under the opposite foot in the case of the hip and knee, and gum and chalk, leather, or poroplastic, for other joints, patients may be allowed to get about to a certain extent upon crutches as soon as the acute period is past, very often with great benefit to their general health. Compression is not of so much service unless there is a large amount of exudation still; but a great deal of good may follow the judicious use of counter-irritants. Blisters, iodine, and the oleate of mercury are of service in the slighter cases only; Scott's dressing is of greater use, as it may be applied as a splint as well; but when there is evidence, from the shape of the swelling and the severity of the pain at night, that the bone is in a state of chronic inflammation, and even in some cases of starting-pains, nothing succeeds like the actual cautery. The broad flat platinum point of Paquelin's cautery answers best. It should be of a black red heat, and should be drawn slowly over the skin in parallel lines, not destroying the whole thickness. Even in disease of the spine I have known great benefit follow from this: the pain is not great; if the patient is under an anæsthetic, and the part is covered up from the air before consciousness returns, it is scarcely felt; very slight suppuration, only of a superficial character, follows; but the tension, and the constant gnawing pain in the deeper structures, are materially relieved; and a great deal of the exudation disappears. In Pott's disease, with paraplegia of not too long standing, the spinal cord sometimes recovers its power within a short time of the application.

Later, when the inflammation has subsided, and stiffness or anchylosis only is left, proper means must be taken to restore the power of the muscles and the mobility of the joint.

2. *Consecutive arthritis.*—The diagnosis of consecutive inflammation from primary arthritis is of especial importance. If, for example, it starts from an abscess in the bone, and this can be opened, so that the pus has free exit before the joint is too seriously involved, complete recovery may be hoped for; and even when there is a sequestrum, and it involves the articular surface, it is sometimes possible to remove it and leave a comparatively useful joint. Where this cannot be done, as in many cases of chronic ostitis of the lower end of the femur, either the joint gradually becomes stiff and almost useless from the repeated attacks of inflammation, or, worse still, the abscess finds its way into the interior and sets up acute suppurative arthritis.

The shape of the swelling is entirely different from that of a primary inflammation of the joint, at least in chronic cases; acute ones run their course too quickly. In the knee, for instance, instead of its following uniformly the outline of the synovial sac, it is very much larger on one side than on the other (figs. 255 and 256), and it begins upon the bone, caused by the swelling and infiltration into the periosteum and the soft tissues lying over it. Tenderness is much greater, particularly over the swelling; sometimes it is definitely limited to one spot, the skin over which is slightly puffy and œdematous. The pain is more severe and of a different character; there is a constant deep-seated aching in one of the bones, worse at night and after any exertion, and severe in proportion to the acuteness of the inflammation. In traumatic cases this is usually very distinct; in tubercular ones, on the other hand, owing to the peculiarly slow and insidious manner in which the affection advances, it is much less clear. Starting-pains occur more early; in synovial arthritis they do not begin until the cartilage is detached and the soft cancellous tissue at the end of the bone exposed; in the consecutive form they commence as soon as the inflammation approaches the articular lamella. For the same reason intra-articular pressure, as when one bone is driven smartly against the other, is a great deal more painful. Finally, muscular wasting is a more prominent feature.

The first object is to check the progress of the inflammation in the bone. For this appropriate constitutional and local measures must be adopted, as already described under ostitis. In tubercular disease an attempt must be made to strengthen the resisting power of the tissues by good food, fresh air, especially at the seaside, iron, cod-liver oil, and other tonics. If it is syphilitic, iodide of potash and mercury in small doses should be tried. The limb should be placed upon a splint, and so long as the inflammation is acute the patient should be confined to bed. Cold may be applied, partly to check the hyperæmia and diminish the amount of exudation, partly in the tubercular form at least, because there is some evidence that it possesses the power of checking the growth of the bacilli; but care must be taken not to lower the vitality of the tissues too much. Leeches are of use when the pain is very severe; in other cases more benefit follows the use of counter-irritants: the actual cautery, if there are starting-pains, iodine, blisters frequently repeated, or, particularly in the case of syphilis, the oleate of mercury with morphia.

In many instances, however, in spite of transient improvement, the pain persists, the swelling refuses to disappear, the effusion in the joint continues, and the local tenderness becomes more and more distinct. When this occurs there must be no further delay, an attempt must be made to reach the seat of the disease by incision in the bone, without, if it can possibly be avoided, implicating the joint. Even if no pus is found, the operation gives relief by diminishing the hyperæmia, with, so long as the synovial cavity is not opened, the least amount of risk. Sometimes the periosteum is thickened or detached from the surface of the compact tissue beneath; occasionally a small sinus can be found, or the bone is altered in texture. In other cases everything appears to be normal; but even then, so great is the risk of leaving a caseous or suppurating focus in the centre of one of the articular ends, that if, before the operation, one spot was definitely tender or œdematous, a circle of bone should be removed with the trephine and the interior explored with a small gouge, or, what answers better, a steel director set in a rounded wooden handle. With this the difference in the resistance offered by healthy bone and by that which is inflamed and softened can be appreciated at once, even when there is no actual cavity.

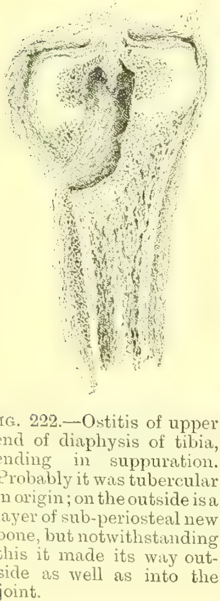


FIG. 222.—Ostitis of upper end of diaphysis of tibia, ending in suppuration. Probably it was tubercular in origin; on the outside is a layer of sub-periosteal new bone, but notwithstanding this it made its way outside as well as into the joint.

If an abscess is found it should be opened freely, any loose fragments of bone that lie in it removed, and the cavity thoroughly scraped so as to destroy all the soft granulation-tissue, washed out with a solution of perchloride of mercury (one part in 1,000), and plugged with iodoform gauze. This may be removed at the end of twenty-four or forty-eight hours, and a large drainage-tube inserted.

If the disease has not yet broken through the articular cartilage an excellent result may be obtained by this; the whole of the os calcis, for example, may be erased, leaving merely a periosteal shell, without the neighbouring synovial membranes being lost. If, unhappily, the disease has spread too far, and suppurative arthritis or pulpy degeneration of the synovial membrane has occurred already, further measures, drainage, arthrectomy, or excision will be necessary, according to the condition of the parts.

Suppurative Arthritis

This, like the former, may either begin in the joint or spread to it from the adjacent structures. It never arises without the presence of pyogenic organisms, acting on tissues the vitality of which is already impaired by other irritants. If these are of but slight intensity and the general nutrition is good, the destruction is limited; if, on the other hand, they are severe (as in septic decomposition), or if the tissues are badly nourished (whether from prolonged intemperance, excesses, kidney disease or other causes), the destruction is wide-spread and complete.

Causes.—The primary form very seldom originates without a wound: exceptionally in those whose health is impaired by intemperance and renal disease, a simple synovitis steadily progresses from bad to worse until at length the tissues yield and give way and suppuration sets in.

The consecutive one is nearly always the result of suppurative ostitis. In acute necrosis the inflammation may spread along the periosteum until it gains the capsule, or work its way between the epiphysis and the shaft, and then turn upwards through the soft tissue of the former until it reaches and undermines the articular lamella. Acute epiphysitis of infants is sometimes known as suppurative arthritis, from the certainty with which the articulation is destroyed. In chronic ostitis, whether tubercular, syphilitic, or traumatic in origin, the joint, if one is near, is always involved: at first, while the focus of disease is still some distance off, the inflammation is simple in character; then, at least in the tubercular form, as the bacilli gain the synovial membrane it becomes specific; and finally, when either an external opening forms or the pyogenic organisms gain the upper hand, suppuration sets in. In other cases the starting-point of the disease is in some neighbouring bursa or tendon-sheath, or even in the cellular tissue around.

Pathological appearances.—The earlier changes are those of acute arthritis; then, as the tissues melt away before the pyogenic micrococci, the destruction becomes more rapid. The synovial membrane grows thicker and thicker, until it simply becomes a mass of inflammatory exudation with scarcely a trace of its original texture left; the loose cellular tissue around swells up and becomes gelatinous; and the interior of the joint is covered with flakes of fibrin and sloughing shreds of tisssue and filled with a turbid mixture of pus, synovia, and débris from its walls. Soon the cartilages lose their pearly-white colour and become opaque. Sometimes, when the tension is not very high, they gradually melt away; more often the central portions, which are pressed together when the bones are in contact, and which are farthest from the vascular circle, perish and drop off as sloughs, bringing with them the articular lamella on which they rest (fig. 223), while around the margin and where the inflammation is less acute, they are gradually eaten out by the granulations in the form of little circular pits (fig. 221). The dense fibrous capsule and the ligaments resist the longest; but in a little while the inflammatory exudation works its way into the interstices; the fibres soften and melt away; yellow foci of suppuration appear in the tissues outside the joint; and the bones become so movable that displacement and even dislocation occur. Finally the muscles waste away and undergo fibroid degeneration; the periosteum is destroyed; the capsule disappears; the pus spreads far and wide in the softened structures around; the skin becomes undermined; and nothing is left but the articular ends of the bones, roughened, softened and carious, bathed in pus and surrounded by suppurating tissues.

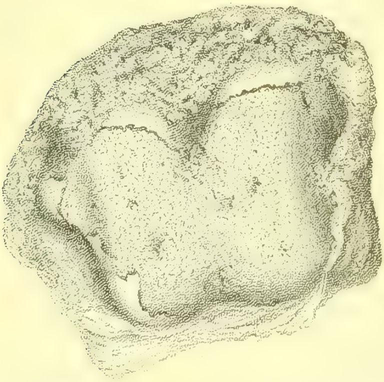


FIG. 223.—Astragalus from a case of acute suppurative arthritis, showing the complete exfoliation of cartilage, except just at the margin.

In the most acute form of suppurative arthritis (that which follows a poisoned wound or complicates acute necrosis) the joint may be completely destroyed within a few days: if the irritant is less intense, the changes take place more slowly; and they may be arrested at any stage; but they are always the same. The difference in appearance arises from the size of the fragments that perish: in the most acute form necrosis is the prominent feature, and the cartilages and the ends of the bones are thrown off in great flakes; in the less acute these are much smaller, and only come from the spots where there is pressure; and in those that are less so still, they are only molecular, the surface imperceptibly melting away.

Repair.—The extent to which this is possible depends upon the amount of destruction. So long as only the synovial and perisynovial tissues are involved, and the cartilages are fairly intact, recovery is possible, though with a considerable degree of rigidity; the joint-cavity is preserved, although the bones are tied together by bands of organised lymph lying in the substance of the capsule and springing from the summits of osteophytes formed round the articular ends. But if, as is usually the case, the cartilages have sloughed, bringing away with them the articular lamella, and the granulations spring from the ends of the bones as well as from the tissues around, when the discharge of pus ceases and organisation begins, the opposing surfaces grow together, the cavity is obliterated, and either dense bands of cicatricial tissue form between the ends, or osseous union, true bony anchylosis, takes place.

Symptoms.—These are the same, both constitutional and local, as those of acute arthritis, but infinitely more severe. When the joint is a large one and the attack acute, death may follow from septic absorption within the first few days. There is a rigor or a succession of chills; the temperature rises rapidly to 105° or even 106° F.; the pulse at first is full and bounding, but in a very short time it becomes weak and feeble; the tongue is dry and brown; sordes appears upon the lips and teeth: delirium sets in; and the patient sinks from acute blood-poisoning without the symptoms abating in the least.

In other cases the constitutional symptoms are less severe; the temperature is exceedingly high, with occasional rigors; at first it is continuous; after a time it falls of a morning, until, when suppuration has become free, it assumes the hectic type. The pulse is soft and compressible without losing its frequency; the appetite is completely lost; the tongue continues dry and brown; the emaciation is extreme, the cheeks become hollow, the eyes dark and sunken, and if the patient escapes pyæmia and other acute infectious disorders, amputation is frequently required, either because the joint is hopelessly disorganised and the limb useless, or to prevent the patient sinking from exhaustion.

In others again, when the suppuration is not assisted by decomposition, or when the joint is a small one—in one of the fingers for example—the effect is very much less, but in acute suppurative arthritis it is always severe.

The local signs are equally grave. If the joint is a large one the whole limb is swollen; the outline of the synovial cavity disappears; the skin is urning hot and dusky red, either in patches or all over; and the inflamma-ory œdema spreads up the whole of the inner side. The pain is most ntense, the patient screaming out if the bed is touched, and the limb is lexed and held perfectly rigid, often grasped with both hands so as to revent the slightest movement. Displacement, if it has not occurred lready, very soon follows. The ends of the bones grate upon each other, wing to the cartilages having sloughed. The starting-pains at night ecome simply agonising; and then, if the patient survives, the skin ecomes thinned at some spot, fluctuation makes its appearance, and the us discharges itself externally.

In acute suppurative arthritis of the knee, it occasionally happens, when his stage is reached, that there is a sudden and most deceptive appearance f improvement: the capsule of the joint gives way at its weakest part, nder the tendon of the quadriceps; the pus escapes and spreads along the emur, until it is turned aside by an aponeurosis; the joint diminishes in size; he tension becomes less; and the constitutional symptoms are decidedly mproved. Unhappily this does not last long: the swelling soon shows itself igh upon the outer side of the thigh, and if the abscess is not opened and rained at once, the symptoms become even worse than they were before.

Diagnosis.—In the acute form, especially that which follows a wound f the joint, there is seldom any difficulty; sometimes, however, when uppurative arthritis sets in as a result of constitutional infection, and it s a question between this and purulent synovitis, the signs are at first ar from obvious. The occurrence of a rigor; a rapid rise of temperature; the hape of the swelling, which is no longer that of the synovial sac; the resence of œdema and of a peculiar dusky redness of the skin, and the in-ense character of the pain, are most significant. In any case of doubt there hould be no hesitation in using the aspirator and withdrawing some of the uid from the interior, with the precautions already described. If the ontents are still thin and serous, the product of catarrhal suppuration, re-noving a certain quantity relieves the tension and the hyperæmia, and then absorption may commence of itself. If, on the other hand, they are thick and curdy, the sooner the contents are evacuated and the tension lowered, the better the prospect of preserving the cartilages and saving the joint.

Treatment.—Suppurative arthritis must be dealt with at once. The synovial cavity must be thoroughly drained; the poison that clings to its walls destroyed or washed away; and all further source of irritation, whether it is septic decomposition, tension, movement or pain, absolutely prevented.

If there is any doubt as to the presence of pus; or if, as in some cases of constitutional infection, there is a suspicion that it is really a purulent catarrh, kept up to a great extent by tension, without the cartilages or the surrounding tissues being seriously concerned, aspiration may be tried. On the other hand, if the skin is red and œdematous, if the shape of the swelling is no longer that of the synovial sac, or if the arthritis is due to a wound, or an abscess that has formed in connection with the bone or one of the surrounding structures and has burst into the joint, the only hope lies in free incision and thorough drainage. The earlier this is accomplished the better. If the patient is not already poisoned by septic absorption, and the synovial membrane is not yet destroyed, a fair amount of movement may be regained; if it is not done in time, either the patient will sink from acute septicæmia or exhaustion, or if he recovers the joint will be hopelessly disorganised.

The limb must be fixed upon a splint, protected with waterproof pads, so that there can be no displacement or spasm, and every part of the joint laid open; the difficulty of accomplishing this, in the larger and more complicated ones, is chiefly responsible for the ill results that follow.

In the case of the knee a free incision must be made down each side of the patella, slanting rather backwards; and a pair of dressing-forceps pushed through the back of the joint into the popliteal space on the outer side of the middle line, until the point is felt beneath the skin. Then a small cut must be made, the forceps driven through, and a drainage-tube drawn back. Even with these three openings, however, drainage is not sufficiently thorough, and the joint must be kept free from any accumulation by some other means. In the early stages continuous irrigation answers admirably, pure water being allowed to flow into the joint at one side, and out again at the other, carrying away with it all the secretion; decomposition cannot occur, as none of the pus is left. But when the smooth synovial surface is destroyed, and abscesses are forming, it is very difficult to make the fluid (which will follow the line of least resistance) circulate sufficiently to wash out all the recesses. More may be done in this case by the introduction of large and firm-walled drainage-tubes at every available spot, syringing out thoroughly with a solution of perchloride of mercury (one part in 2,000), and then covering the whole with a thick layer of absorbent moss or wood-wool. The poison is partly washed away—partly, so far as it lies upon the surface, destroyed by the action of the antiseptic; tension is impossible; decomposition cannot occur without fluid; absolute rest is ensured; and the gentle elastic compression effectually prevents hyperæmia and limits the amount of exudation.

In the case of the ankle, elbow, wrist, and the smaller joints, the same plan may be followed, varied slightly in its details. Thus it is more effectual to immerse the part bodily in a solution of perchloride (one part in 10,000) for two or three hours after the incisions have been made; and iodoform may be freely dusted in as soon as the fluid has drained away; owing to the smaller absorbing surface, there is less risk of poisoning. Even when the joint is loose and grating, a very fair result may frequently be obtained by means of this kind: the suppuration ceases, the granulations begin to organise, fibrous bands form around, or, if the disease is far advanced, between the bones, and repair takes place so far as the previous destruction and the health of the patient will allow it.

Great care is required throughout to keep the limb in position and prevent displacement. Partly owing to the weight of the lower segment, partly to the action of the flexor muscles, one bone is certain to be displaced from the other if the joint is left to itself without proper splints; and later, when the attack has subsided and the cicatricial tissue has begun to contract and grow rigid, there may be the mortification of finding that the joint is fixed in such a position that the limb is almost useless, unless excision or some other operation is performed.

Amputation may be required in the later stages of the disease, to prevent the patient sinking from hectic or exhaustion, or because the limb is too much disorganised to be of any use. It should never be performed during the acute inflammatory period, except as a last resource to save the patient from dying of septicæmia, and then, if the joint is a large one, the prognosis is almost hopeless. In the elbow and shoulder, very good results may be obtained by excision, better than by waiting for anchylosis; and the same plan may be followed in the case of the hip, when the upper extremity of the bone or the acetabulum is extensively diseased, with the view of saving the patient from the effects of prolonged suppuration.

PYÆMIC ARTHRITIS

Inflammation of joints is of common occurrence in pyæmia, although, without any reason being known, it varies very much both in frequency and intensity. In some cases a large number of joints is involved within the first few days, and if the patient lives sufficiently long, the destruction is rapid and complete; in others only one is attacked, or one or two at long intervals, and the effusion remains in the condition of a simple purulent synovitis for a considerable time before it involves the tissues around.

It always begins as synovitis, and the effusion is purulent from the first; generally it is of a peculiarly oily character, and greenish or yellow in colour, from the blood with which it is mixed. If the attack is an acute one, this is soon succeeded by suppurative arthritis: the synovial membrane becomes swollen and vascular, the surrounding tissues sodden and œdematous, and within forty-eight hours the cartilages undergo necrosis and the joint is hopelessly disorganised. If, on the other hand, it is chronic, the interior of the joint may retain its smooth and even character for days, without any evidence, even of hyperæmia; and at the end of that time the effusion may spontaneously disappear, leaving the joint capable of a certain range of movement, but generally more or less crippled from fibrous adhesions, or weakened from the extreme distension of the capsule.

Symptoms.—Pyæmic synovitis is rapid and very insidious in its onset, often beginning without any complaint of pain. One of the joints, especially the knee, or (it is said) the right sterno-clavicular, suddenly becomes filled with fluid; the synovial cavity is distended; fluctuation is distinct; and the limb assumes of itself the characteristic flexed position. The skin at first is pale, or marked by a scattered erythema; very soon, if the capsule gives way, it becomes soft and doughy, pitting on pressure, and of a peculiarly dusky hue; and then, as a rule, the pain becomes very severe. In the acute cases a rigor is not uncommon at the commencement; the muscular wasting is peculiarly rapid; the cartilages may be destroyed within forty-eight hours; starting-pains are very severe; and, owing to the great amount of fluid and the rapidity of the destruction, displacement of the ends of the bone is very likely to occur, unless special precautions are taken to prevent it. In the more chronic ones there is less heat and less tension; the skin is unaffected; often there is no increase in the constitutional symptoms; and not unfrequently the effusion disappears from the joint almost as rapidly as it came, and perhaps makes its appearance in another. Pathological dislocation, particularly of the hip-joint, is not uncommon under these conditions, forming the so-called *dislocation by distension*: the head of the bone lies still within the capsule, which it has stretched over itself. It differs from *dislocation by destruction* in that the cartilages on the articular surfaces and the bones beneath them are intact.

Treatment.—Careful examination should be made every day in a case of pyæmia to make sure that no joint is attacked. At the first sign the limb should be placed on a splint in a suitable position, well packed with cotton-wool and bandaged. The effusion may subside within twenty-four hours, leaving the articulation stiffened and weakened, but without any more serious result; but if it continues, or if the tension increases, or the skin becomes red and dusky, steps should be taken at once to empty it thoroughly. Aspiration may be tried first; and occasionally after this absorption begins and there is no re-accumulation; more frequently the improvement is only temporary, and it becomes necessary to lay the joint open freely, wash it out thoroughly with some antiseptic, if possible before the surface is destroyed, and drain it. Even after this, supposing the pus is not allowed to collect anywhere in the interior, recovery with a certain, though limited, amount of movement is possible; much more frequently, however, either the cartilages undergo necrosis, granulations spring from the ends of the bones, and osseous ankylosis ensues; or the patient sinks from some other, often visceral, complication, or from exhaustion. Amputation, if the patient recovers, may be required at a later period, either because the limb is useless, or to save the patient from hectic or amyloid disease.

Puerperal Arthritis

This is a form of pyæmia consequent on septic absorption from the interior of the uterus after parturition, due in most cases to the retention and decomposition of some portion of the placenta. So far as the joint affection is concerned, it does not differ materially from other forms; occasionally it is very acute, leading to rapid disorganisation and destruction; more frequently it is subacute or chronic, affecting often the knee-joint only; and then, supposing the uterus is thoroughly disinfected, and no further absorption or complication sets in, the prognosis is fairly good.

EXANTHEMATIC ARTHRITIS

Inflammation of the joints is of common occurrence in connection with the exanthemata, sometimes appearing during the course of the disease, more frequently afterwards, as one of the sequelæ. In many cases it is distinctly pyæmic, due to septic absorption from ulcers upon the skin or the mucous membranes, and does not differ in any material respect from ordinary pyæmia; in some, however, it never passes beyond the stage of synovitis, and the effusion is absorbed again without leading to any more serious result than stiffening or weakening of the articulation; and occasionally it is to all appearance identical with acute rheumatic fever or the acute form of osteo-arthritis.

In typhoid, the hip seems to suffer more frequently than other joints; and even dislocation may take place suddenly, without warning of any kind. The muscles are relaxed; the capsule of the joint is distended; the fluid gradually insinuates itself between the articular surfaces, and a very slight degree of flexion and abduction is sufficient to tilt the head of the bone out of the acetabulum. Owing to the want of power of the muscles, and to the fact that the capsule is not torn, the symptoms at the first are not so marked as in traumatic dislocation; later, when the patient recovers, the deformity becomes characteristic.

Scarlatinal arthritis is generally polyarticular, and closely resembles acute rheumatic fever, affecting sometimes the pericardium or the cardiac valves, and being followed occasionally by embolism and chorea. It usually occurs during the decline of the fever or even during the period of convalescence. In other cases it is distinctly pyæmic, ending in suppuration. Variola, measles, dysentery, and even mumps, are in rare cases followed by similar consequences.

URETHRAL ARTHRITIS

Closely akin to this is a form of arthritis dependent upon some lesion of, or injury to, the genito-urinary mucous membrane. It is most common after gonorrhœa (though the proportion of cases in which it occurs is exceedingly small), whence its common name, gonorrhœal rheumatism; but it may follow any urethral discharge, or even the passage of a catheter, and, though much more rarely, a similar affection may occur in women in connection with menstruation, following parturition or dependent upon leucorrhœa. According to Clement Lucas it is present sometimes in cases of ophthalmia neonatorum.

The nature of this affection is even more doubtful than that of the exanthematic variety. In some cases it appears to be pyæmic, due to septic absorption from ulceration of the urethra, and ending in acute suppuration and destruction of the joint; but in the majority there is very little tendency to the formation of pus. That it is directly connected with the condition of the urethral mucous membrane is shown by the fact which has many times been noted, that the inflammation is liable to return, not only with every succeeding attack of gonorrhœa, but even when, without this, the urethral mucous membrane is subjected to any unusual degree of irritation (possibly in these cases the gonorrhœa is latent). It seems probable that it is due to the absorption of some poison from the urethra, and the gonococcus has been found on several occasions in the fluid of the joint; but it is also possible that it may be the result of reflex irritation of the nervous system. Ord, for example, has shown that a form of arthritis not altogether unlike this occasionally attacks women who suffer from menstrual troubles, the inflammation returning at each period until the climacteric is passed; and although this, too, may be explained as a result of absorption, it is peculiarly significant that in several of the cases in which there was ovarian tenderness with neuralgia on one side of the body, the disease was limited to the joints on that side.

The clinical symptoms and the pathological changes in some of the more severe cases resemble those of acute osteo-arthritis, especially that variety which occasionally follows exposure to cold or over-exertion shortly after parturition or miscarriage; but the analogy must not be pushed too far. Heart complications are not unknown in connection with it, but they are decidedly rare.

Symptoms.—Urethral arthritis exists in two well-defined varieties: acute, attended with fibrinous effusion, and involving all the fibrous tissues around and belonging to the joint, so that, when it subsides, dense fibrous anchylosis is left; and chronic, in which the symptoms are not so severe and the effusion is serous in character, but which also leaves behind it considerable stiffness. As in pyæmia, tendons and tendon-sheaths are not unfrequently attacked as well, and occasionally other fibrous tissues not connected with joints, such as the lumbar aponeurosis, the annular ligaments, and even the sclerotic coat of the eye.

The acute form is not unlikely to be mistaken for acute suppurative arthritis, though pus is rarely present, and the constitutional symptoms are much less intense. There is seldom a rigor, although a certain amount of shivering is not uncommon; the temperature is not very high or the pulse rapid, and the appetite even may be fairly good. At the first onset, several joints are swollen and painful, but it soon settles down to one or two of the larger ones, the knee and ankle in particular. The skin is tightly stretched, red and shining; often there are red lines running up to the neighbouring glands, but it does not pit on pressure; the outline of the part is even and rounded, the shape of the synovial sac is lost, the tendon-sheaths and the fibrous tissues around are filled with inflammatory exudation, the temperature is raised, and the pain, especially when the part is touched or moved, is almost intolerable. The worst points generally correspond to the attachment of the ligaments. At the end of a week or ten days the severity of the symptoms begins to subside, the pain becomes less intense (except when an attempt is made to move the part), the redness disappears, and the skin becomes more or less wrinkled. The effusion is absorbed to some extent, but a very great deal of it becomes organised inside the joint as well as round it, and the anchylosis may be so firm as to give rise to the suspicion of its being osseous. For this reason, and because the ligaments become soft and yielding almost at the first, very great care is necessary to prevent displacement and to keep the joint fixed in the most useful position.

In the chronic form the exudation is less fibrinous and is restricted chiefly to the interior of the joint. The shape of the swelling follows the outline of the synovial sac, there is less exudation around, the pain is not so severe, the patient may even be able to get about to some extent, and, although there is a great tendency to recurrence, each time interfering with the action of the joint more and more, there is rarely the same rigid degree of anchylosis. Softening of the ligaments, however, is very liable to occur, and if the tarsal joints and the plantar ligaments are involved, a very painful form of flat-foot may result.

The diagnosis of the acute form rarely presents any difficulty; in no other variety of inflammation, scarcely even in acute rheumatic fever, is the pain so intense, and from this it can be distinguished at once by the difference in the constitutional symptoms and the extent to which the effusion involves the periarticular tissues. The chronic variety, on the other hand, closely resembles subacute and chronic synovitis, especially when it involves the keee-joint only, and it is not improbable, especially as in many cases there is only an insignificant gleet, that the real cause is frequently overlooked.

Prognosis and treatment.—Urethral arthritis is naturally more common in young adult life, but it may occur at any age, and when it is due to gonorrhœa, it may set in at any period of the disease. Perfect recovery is rare; absolutely rigid anchylosis, with complete muscular atrophy, is not uncommon, and the disease may return again and again until the patient is hopelessly crippled.

The condition of the urethra or vagina requires particular attention; every attempt must be made to allay the irritation of the mucous membrane as soon as possible. The use of sedative and astringent injections and bougies does not appear to be attended with any special degree of danger. Constitutional treatment, so far as the joint affection is concerned, is of very little avail. Iodide of potash, salicylate of soda, and the other remedies usually of service in rheumatic fever, seem here to fail completely. The chief reliance must be placed upon local measures, and especially upon those that check the effusion. The limb should be placed upon a splint and raised, the skin covered over with extract of belladonna and glycerine, invested with layer after layer of cotton-wool, and then bandaged as tightly as possible. In acute cases it is necessary to place the patient under an anæsthetic to effect this thoroughly, owing to the severity of the pain; and, as a rule, it is as well to give a hypodermic injection of morphia as soon as consciousness returns; but there is nothing so effectual for getting rid of the exudation, and, as this subsides, the pain and the inflammation and the tendency to displacement disappear with it. It may require renewing on the second or third day, and by that time the outline of the bones is fairly distinct again.

After the acute stage has subsided and the joint has become cold, every attempt must be made to restore its mobility. Blisters and counter-irritants may be used to procure resolution of the exudation that has become already organised, or the adhesions may be broken down under an anæsthetic; passive motion and massage must be commenced as soon as the condition of the part will allow it, a certain amount of pressure being maintained in the intervals by means of properly contrived elastic supports; and hot-water douching, galvanism, friction, and every other measure that can improve the circulation and nutrition must be employed to prevent the wasting of the muscles and the stiffening of the joint. Improvement is always gradual, and there is at first a great tendency to relapse, so that a certain amount of caution is necessary; but if the treatment is kept up, a very great deal may be effected, so long, at least, as the adhesions are extra-articular ; if they lie nside the synovial cavity they are almost sure to form again, however often hey are broken down.

Gouty Arthritis

Gouty arthritis is occasionally met with in young adults, and has even been known in children, but is much more common towards and after middle ife. It may be acute or chronic ; the former, at least, is much more frequently met with in men than women. The tendency to it is hereditary, but the number and severity of the attacks are dependent, to a very large extent, upon the mode of life, and particularly upon the diet of the individual. The smaller joints are usually affected first, especially the metatarsophalangeal articulation of the great toe (possibly because it is so liable to njury from ill-fitting boots), but none are exempt, and it is not uncommon to find, *post mortem*, abundant deposits of urate of soda in all the larger bones, even though there is no history of their having been inflamed.

In acute cases, provided the joint has not been attacked many times before, the changes are merely those of acute synovitis : all the softer tissues are hyperæmic and filled with exudation ; the cavity is distended with a more or less turbid fluid in which there is abundance of urate of soda, and all the loose tissue around is infiltrated too. In chronic cases and after repeated attacks, the changes are more permanent. In the slighter forms there is merely a chalky deposit of urate of soda on the surface and in the substance of the cartilages ; but, after the disease has lasted some time, the bones, ligaments, and all the structures around are loaded with masses of the same material to such an extent that nodes formed from it (*tophi*) project beneath the skin. Coincident with this, and possibly to some extent dependent upon it, are degenerative changes, similar to those met with in other examples of chronic inflammation. The matrix of the cartilage breaks up into fibrils, the corpuscles increase in number, and where there is any pressure or friction it becomes so absorbed and worn that in places it disappears altogether and leaves the surface of the bone exposed. Then this undergoes similar changes : the margins grow out into irregular nodules, the shape of the articular surface is entirely altered, and the distortion and mpairment of mobility are as bad as in chronic osteo-arthritis. Later, suppuration may break out in the cellular tissue, leaving sinuses discharging a chalk-like substance from time to time ; and anchylosis even has been known to occur in cases in which the inflammation was more than usually persistent.

The symptoms of an acute attack are very characteristic. It nearly always begins in the night, towards early morning ; sometimes it is preceded by general malaise for several days ; occasionally it follows an accident. The pain is most intense, coming on in paroxysms ; it is usually described as resembling the boring of a red-hot iron. There is the most extreme tenderness, even the pressure of the sheet cannot be borne. The skin is of a peculiar dusky-red colour ; the whole of the joint is swollen and burning hot, and all the surrounding tissues are thickened and œdematous. At the first onset there may be a feeling of chilliness, even a slight rigor ; very often there is a certain degree of fever, but it is seldom severe, and usually subsides of itself in the course of the morning as the pain grows less intense. In really bad cases this is repeated night after night for upwards of a week, the days being passed in comparative comfort, except for the feeling of exhaustion and distress, the nights in agonising pain. As the attack subsides the swelling disappears, the skin over the joint peels off, and if it is the first, or one of the first, no visible effect is left. Not unfrequently a second or even a third joint is attacked as the first is getting well, but the inflammation is seldom so severe.

In the chronic form the pain, heat, swelling and redness are not so marked, although they vary very much from time to time and the patient is seldom free from them for long. The amount of deformity is much more serious; the loss of mobility is often very great, and there is an especial tendency to the permanent deposit of urate of soda in the form of chalk-stones. The hands are nearly always affected; the metacarpo-phalangeal joints are flexed and adducted, so that the fingers slant down to the ulnar side; distal phalangeal ones may be hyper-extended; the knuckles are enlarged and flattened; movements are much impaired; the skin is smooth and glossy, and the temperature is usually raised. Other signs are generally present to assist the diagnosis. Little cysts filled with fluid form on the dorsal surface and sides of the fingers; neuralgia and cramp are of common occurrence; a burning pain in the heel is very often experienced, especially at night; there is a constant tendency to flatulence and dyspepsia; the urine is loaded with uric acid, giving rise to attacks of urethritis and cystitis; the skin is liable to eczema and psoriasis, the tongue and the pillars of the fauces become smooth and glossy; the teeth become loose, and without the least sign of decay drop out quietly of themselves, and the least indiscretion in diet causes the greatest distress.

Treatment.—Rest, position, a moderate degree of warmth, and, if it can be borne, the pressure of cotton-wool lightly applied, are especially useful in moderating the hyperæmia of the acute form. The pain may be relieved to some extent by laying over the part lint dipped in a lotion containing a grain of atropin and eight grains of morphia to the ounce, and covering it with oiled silk; or by using a solution of menthol in the same way. Lead lotion is better avoided, and leeching is positively injurious. The bowels should be opened freely and as soon as possible, preferably with grey powder or calomel and colocynth; and if the patient is young and healthy and the attack is severe, colchicum should be given with small doses of iodide of potash, quinine, and sulphate of magnesia. Whether it should be tried in other cases is more doubtful; its value is proportionate to the acuteness of the attack; in many people it causes sickness, purging, and great depression; so that if it has disagreed with the patient on any previous occasion, or if the pulse is weak and feeble, and particularly if the gout is chronic, never really disappearing, and the present attack is merely a sudden exacerbation, it should be given in very moderate doses, and for a short time only, leaving off at once if any signs of depression make their appearance. On the other hand, there is no doubt that it agrees exceedingly well in many cases, and that by taking it occasionally with quinine, and using other precautions, many patients are able to keep themselves free from severe or prolonged attacks for years without suffering any ill effect.

In the chronic form a great deal may be done by appropriate treatment to relieve the stiffness of the joints and prevent wasting and deformity. Warmth is especially serviceable; sometimes, when there is a large deposit of urate of soda, a lotion containing a drachm of bicarbonate of soda or five grains of lithia to the ounce, may be applied with benefit. Hot fomentations local vapour-baths, and massage, gently applied so as to encourage the flow of lymph as much as possible, are certainly of use. In some places, especially over the knuckles, the skin has a tendency to give way and leave persistent ulceration, but every care should be taken to keep it intact as long as possible.

The general treatment, both in the acute and chronic form, is even more important. The diet must be carefully restricted : it must be nutritious and palatable, but all highly seasoned and rich dishes should be avoided, and particularly any excess in meat. Alcohol is better abandoned altogether, certainly malt liquors must be ; but a distinction must be drawn in this respect between an acute attack of gout in a young man and an apparently similar complaint in one who is old and feeble, unable to digest without assistance, and liable to attacks of cardiac intermittence from dyspepsia ; champagne, sherry, and new wines of all kinds should, however, certainly be interdicted ; whether port, particularly old port, in moderation deserves the opprobrium that has been heaped upon it is more than doubtful ; certainly it is less injurious than many kinds of so-called claret. Alkalies may be taken in moderation, but it must be remembered that many of them, particularly the potash salts, have a distinctly lowering effect. The large amount of fluid that is usually taken with them in the form of mineral waters is beneficial to some extent, as it prevents concentration of the urine and increases the amount of excrementitious matter discharged. Tonics, iron and quinine, are often necessary, especially in the chronic form. Baths are of the greatest value, though much of the reputation many foreign health-resorts enjoy is really earned by the dietetic and other restrictions that are willingly submitted to away from home. The clothing should be warm, a fair amount of regular exercise taken, the condition of the bowels and the state of the digestion carefully attended to, and overwork, mental as well as bodily, avoided as far as may be.

Rheumatic Arthritis

In acute rheumatic fever, although the effusion is chiefly collected in the synovial cavity, the surrounding tissues are always infiltrated to some extent. As a rule it subsides without leaving any permanent change ; the exudation, which is rather more fibrinous than it is in simple synovitis, is completely absorbed, and the joint, though it may be stiff for a time, recovers its mobility. Sometimes, however, the attack persists and becomes chronic in one or more of the joints, and occasionally it is chronic from the first, the inflammation coming on slowly and quietly as a result of exposure to cold and wet. In these cases the tissues are liable to undergo more permanent changes ; the cartilage is opaque and dull ; the surface is irregular ; it is thickened in some places and thinned by absorption in others ; the cells are increased in number and their definite character is lost ; the matrix is fibrillated, giving it a velvety appearance, and in a few cases even the bone underneath is unduly vascular. In short, the changes are practically identical with those that occur in osteo-arthritis, and the resemblance is heightened by the fact that, in very old-standing cases, eburnation may be present, and outgrowths, partly cartilaginous, partly bony, form round the edges.

In the acute stage the symptoms are thoroughly characteristic, and there is rarely any difficulty in the diagnosis. Later, however, when merely the chronic degenerative changes are left, there is such little difference between this affection and many of the diseases that are classed together under the general name of osteo-arthritis that a separate description is unnecessary. The chief feature is the rigidity and thickening of the capsule and periarticular tissue, consequent upon the organisation of the exudation, but this is by no means confined to this disease and cannot be regarded as distinctive.

OSTEO-ARTHRITIS

Osteo-arthritis is a general term applied to a group of diseases which resemble each other more or less in their pathological features, but which differ widely in their symptoms, causes and results. Many of them have been described already under different headings, and will only be alluded to here. Rheumatoid arthritis, chronic rheumatic arthritis, arthritis deformans, rheumatic gout, nodosity of the joints, malum coxæ senile, and many other names have been given to some of its varied forms.

Pathology.—The pathological appearances are distinctive. The centre of the articular cartilages, where they are subjected to the greatest amount of friction and are farthest away from the arterial circle which supplies them with blood, becomes rough and fibrillated, so that, when placed under water, the surface has the appearance of very coarse velvet (fig. 224). The upper layers are affected first; the primary capsules are enlarged and filled with secondary ones; the matrix is softened; the capsules form communications with each other; the superficial ones degenerate, break down, and discharge their contents into the joint; and at length only a number of fibrils is left, pro-

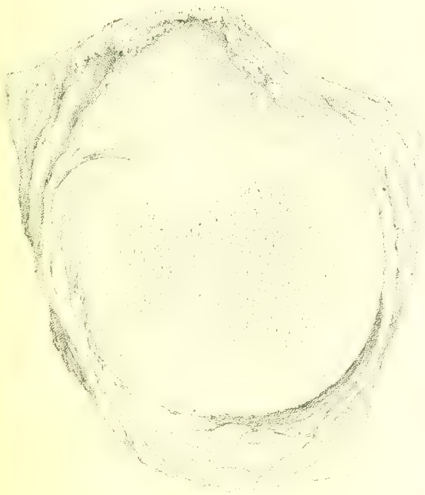


FIG. 224.—Under surface of patella, showing velvety degeneration of cartilage in incipient osteo-arthritis.

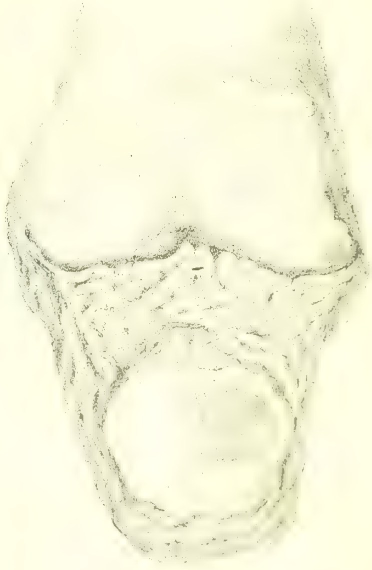


FIG. 225.—Knee-joint showing the cartilage removed from corresponding surfaces of patella and external condyle, with lipping of margins and thickening of synovial folds.

ecting side by side into the synovial cavity. Gradually the degenerative process involves these too, and the cartilage disappears layer by layer until the bone is exposed (fig. 225).

This soon becomes affected in the same way ; the cancellous tissue of the articular ends grows more open and more vascular ; absorption takes place where it is subjected to pressure ; the shape is altogether changed ; and even when no marginal outgrowths are produced there is a very considerable degree of deformity (fig. 227). The superficial layer, however, in many cases undergoes a totally different transformation : it becomes harder and denser, until it resembles ivory or porcelain. Whether it is a product of the articular lamella, or is due to calcification in the deeper layers of the cartilage, is uncertain ; but in any case it becomes white, dense, and highly polished from the friction it receives. In some cases the whole of the articular area is eburnated in this way and the surface is perfectly uniform and even ; in others, especially in hinge-joints, it is cut into grooves from mutual friction (fig. 226) ; and in others again worm-eaten patches and bright highly polished ones lie side by side.

Around the margin of the joint, where there is no pressure, the effect of the continual irritation is altogether different. Fibrillation of the matrix and proliferation of the cells take place it is true ; but, instead of being worn away, the cartilage increases immensely in thickness and forms overhanging lips and nodules which project over the articular edge. Later, many of these become ossified, and at length, as the bone is gradually worn away in the centre, and produced in excess all round the margin, the shape of the surface becomes entirely altered. The head of the femur, for example, is worn away and flattened from above ; the neck is absorbed ; while beneath, on the under surface, there is an immense accumulation of new-formed tissue. As a rule, when this occurs, the opposing surfaces are similarly affected. Sometimes a fair amount of movement is still allowed to take place between them ; but occasionally they lock into each other and become dovetailed in such a way that practically the joint is fixed : true anchylosis is rarely met with except in the spine. Osteophytes of a similar description are produced on the shaft of the bone, around the attachment of the capsule, and higher up in connection with the periosteum, but

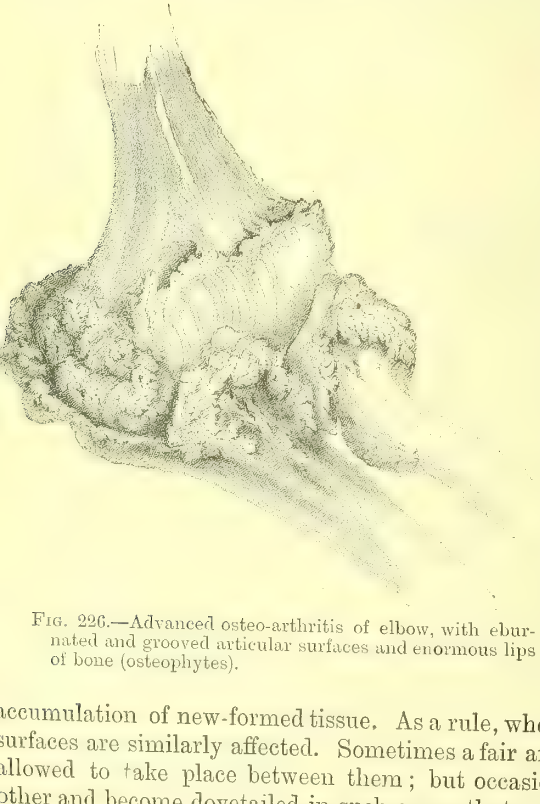


FIG. 226.—Advanced osteo-arthritis of elbow, with eburnated and grooved articular surfaces and enormous lips of bone (osteophytes).

their size diminishes rapidly as they recede from the joint (fig. 226). Occasionally plates and nodules of cartilage and even of bone are produced independently in the thickness of the fibrous tissue.

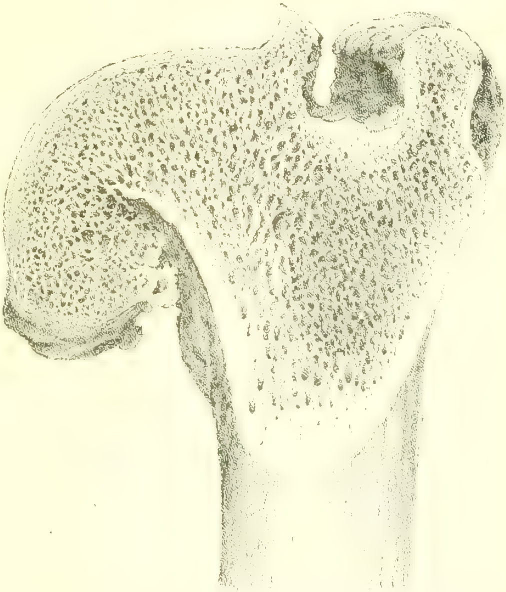


FIG. 227.—Head of femur, showing the absorption above and the accumulation below, until an appearance is produced closely similar to that of impacted intra-articular fracture with bony union.

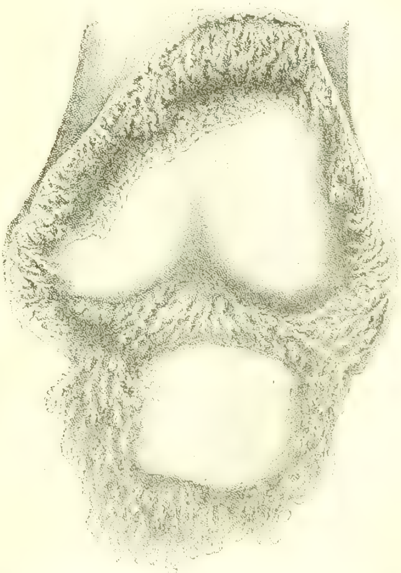


FIG. 228.—Papillary synovitis with but little change in the cartilages.

It is probable that the change is first manifested by the cartilages, but the *synovial lining* of the joint is affected almost as soon. It becomes more vascular and swollen; the fat-cells disappear; the exudation that is poured out from the blood-vessels undergoes organisation, and the folds and fringes, which normally are but slightly developed around the margins of the joint, become enormously hypertrophied. The surface is roughened with numerous little outgrowths, and these increase in number and size until they form pedunculated masses, which branch in all directions and cover the whole of the interior. In extreme cases, there is no trace of the original structure to be seen at the base. Very often the ends of these growths become bulbous or club-shaped, and then cartilage-corpuscles and sometimes even bony nuclei make their appearance in them. Occasionally they are detached altogether and drop off as foreign bodies (fig. 228).

In the early stages the *capsule and the ligaments* rarely show any extensive change; they are merely swollen and thickened in proportion to the hyperæmia; but later they may be profoundly affected. Sometimes they are rigid, contracted, and incorporated with the fibrous tissues around, until movement is almost impossible; sometimes, on the other hand, they appear to degenerate, and are softened and loosened to such an extent that the ends of the bones become displaced, and even dislocation may occur. As in the other tissues, the result of the persistent irritation is sometimes thickening and organisation, sometimes degeneration and absorption, according to the pressure and friction to which they are subjected.

The *interior of the joint* presents the most varied appearance. In some cases, as already mentioned, it is covered all over with arborescent growths; in others there are only a few large ones here and there; and in others again it is immensely enlarged and perfectly smooth, as if the fibrous tissue of the capsule had become thinned and atrophied. Not unfrequently these different conditions may all be met with together. In one place there are dense rigid bands standing out by themselves; in another the fibrous tissue is thin and yielding, and is forced out among the surrounding structures so as to form a kind of hernial protrusion. Large pouches developed in this way, and communicating by a long and narrow neck with the synovial cavity, are of common occurrence in many forms of osteo-arthritis. Sometimes they are formed from bursæ, which undergo similar changes and gradually enlarge until they come into contact and finally into communication with the joint; much more often they are genuine *hernial protrusions*, due to the thinner and weaker parts of the capsule being slowly forced out by the intra-articular pressure. They are most common in the knee, projecting through the posterior ligament, but I have met with them in the ankle, elbow, shoulder, wrist, and hip. They may be very small; but not unfrequently, especially when they find a convenient interspace, they form gigantic thin-walled cysts, which approach nearer and nearer to the skin until they either break of themselves or are opened. In the knee they may stretch half-way down the leg, and point in the calf below the muscular mass of the gastrocnemius; in the shoulder they form a swelling under the coracoid process and down below the middle of the arm, along the course of the biceps tendon; in the ankle they may occur either at the front or the back of the joint; but, wherever it is, the place of their appearance is no proof of the place of their communication. I have many times dissected them out and have often found a long devious channel, winding under the tendons, so that when pressure was made upon the sac the sides were brought together and none of the fluid could be returned into the joint. This fact should be carefully noted, as it is by no means uncommon to find large cystic swellings of this sort without any clear evidence of disease of the joint; and in such cases it is exceedingly difficult to prove that no communication exists.

The *synovial fluid* is equally variable; generally it is fairly clear or slightly turbid, especially when the attack is acute; occasionally it is a light straw colour and gelatinous in character, not like synovia; in some cases the quantity is enormous; and in others it may be so scanty that much of the pain and difficulty of movement may be reasonably assigned to its deficiency.

Muscular wasting, affecting the extensors first, but by no means confined to them, is peculiarly rapid in this form of arthritis. The tendons in the neighbourhood of the joint sometimes become ossified; more frequently they are completely worn away, especially when, like the biceps, they traverse the synovial cavity; this one frequently disappears altogether, the muscle forming a new attachment to the groove of the humerus as it passes out under the capsule, and the head of the bone developing a new socket on the under surface of the acromion (fig. 229). Even the surrounding connective tissue becomes œdematous, infiltrated with lymph in parts, and absorbed in others, so that the outline of the limb is altered altogether and the skin is shiny and smooth.

Suppuration is exceedingly rare. When it does occur it is nearly always due to the formation of hernial protrusions which have grown so large that at length they have either been opened or have broken of themselves, and so have established a communication between the joint and the exterior. Sometimes, however, even then the tissues are able to resist successfully. I have known a chronic sinus in the arm in connection with osteo-arthritis of the shoulder discharge for years without destructive inflammation ever setting in.

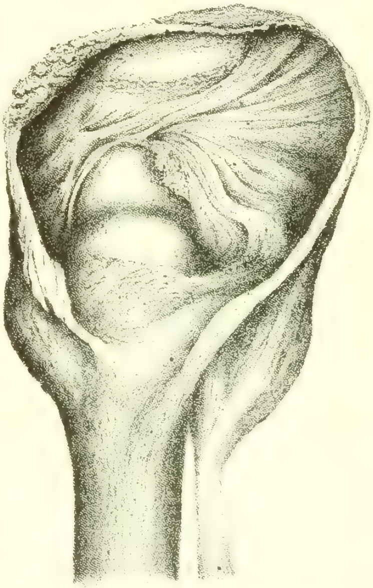


FIG. 229.—Shoulder-joint laid open from the outside. The biceps tendon is absorbed and has formed a new attachment for itself in the groove; the head of the bone has left the glenoid fossa and formed a new highly-polished articular facet for itself on the under-surface of the acromion. The interior of the synovial cavity is thrown into folds. The affection is nearly always bilateral, which effectually excludes the idea of injury.

The true nature of this affection is very obscure. It may be acute, but nearly always it is very chronic. In part it appears to be a result of simple degeneration, for slight degrees of it are met with in healthy old age and in joints that have been kept at rest for a long time; but as a rule there is in addition distinct evidence of some slight but persistent irritant impairing nutrition still further, and leading to the production of the irregular hypertrophied masses round the margins. Occasionally it occurs in children (the acute form only); but with this exception it is distinctly a disease of advancing age. In many instances no definite cause can be found; in a large proportion there is a family history of gout, rheumatism, or both together. Constant exposure to cold and wet undoubtedly brings it on, and partly from this, partly because there is a hereditary tendency to it, it is much more common in certain countries than in others. Sometimes, especially in the hip, it occurs very rapidly after injury. Its symptoms in certain cases are so severe and the pain so great that it may easily be mistaken for acute rheumatic fever; in others it appears to be a sequela of this disease. Finally a peculiar variety of it, associated with very definite clinical symptoms, occasionally breaks out suddenly in the course of certain affections of the nervous system, chiefly locomotor ataxy.

Acute osteo-arthritis.—This form is distinguished from the others by the severity of the symptoms and the rapidity of its onset. It is more common in women than in men, and may appear at any age, even in childhood. The most striking feature is the extreme degree of rigidity it leaves The fibrous structures are the parts chiefly involved; there is very little eburnation, and it is not usual to find much marginal hypertrophy; the synovial membrane is velvety and thickened; there is no excess of fluid; the cartilage is thinned and eroded in places; but the capsule, ligaments, and all the connective tissue around are welded together into such a rigid mass that there is scarcely any possibility of movement. In some cases the ends of the bones are displaced as well; in others the rigidity is made worse by the degeneration of the muscles which become converted into fibrous cords.

This condition, or one resembling it so closely that it cannot be distinguished, is met with under very varied circumstances. It is most common in young women, and can sometimes be traced to menstrual irregularity; not unfrequently, especially when there is a strong family history of gout, it is assigned to exposure, to cold or wet; sometimes it does not set in until the climacteric; and I have known an exceedingly severe form occur from catching cold three weeks after parturition. Urethral arthritis, scarlatinal rheumatism, and acute rheumatic fever, are all of them occasionally followed by it, convalescence progressing up to a certain point, and then fresh and even more persistent trouble making its appearance; and at times it breaks out suddenly with a severity only equalled by that of rheumatic fever, without its being possible to assign a reason.

The larger joints are usually the ones attacked, often several of them at the same time; but there is no tendency for the inflammation to fly from one to the other as it does in rheumatic fever. The affected parts are exceedingly painful; there is a considerable degree of swelling, but round the joint rather than in it; the skin is hot and red; there is great tenderness on pressure, very often for some distance above and below; and the least attempt at movement is checked by the muscles at once. The constitutional disturbance is not very severe: that is to say, the fever is not very high; and the profuse sweating and the tendency to involve serous structures which are so characteristic of rheumatic fever are rarely present. As the inflammation subsides, the swelling is gradually absorbed; the tissues begin to waste; and the ends of the bones and the rigid tendons and muscles stand out prominently under the skin. Relapses and prolonged convalescence, often lasting for years before it is really thorough, are the rule.

The treatment of this affection is very unsatisfactory. If there is a distinctly gouty history, small doses of colchicum with alkalies and iodide of potash may be tried; guiacum is entirely useless and salicylate of soda seems to have but little real effect. The anæmia, which always accompanies it, and which often persists afterwards, should be treated with iron, cod-liver oil, quinine and arsenic. During the acute stage the diet must be restricted, but afterwards it should be nourishing, without being too rich. Whatever precautions are taken, more or less rigidity is sure to be left, so that it is absolutely necessary to keep the limbs in proper position by means of splints from the very first. Pressure and cold may be used to limit the amount of exudation, opium and belladonna to relieve the pain; later, when the acute stage has subsided, counter-irritation, especially flying blisters, applied every two or three days to different parts of the joint, massage, warm douching, and prolonged hot-baths are of the greatest service. Galvanism has undoubtedly some influence in maintaining the nutrition of the muscles, and may be used for this. Afterwards, when the inflammation has altogether disappeared, and the joints are left rigid, wasted, and more or less anchylosed, an attempt may be made by means of tenotomy, passive motion, and breaking-down the adhesions, to restore them to something like their normal condition.

Chronic osteo-arthritis.—This exists in many forms, but they all agree in being peculiarly insidious in their onset, and as a rule steadily progressive, although every now and then their course is interrupted by a subacute attack.

One of the most common begins in the smaller articulations, usually rather late in adult life, and spreads gradually from them to the larger. It is more frequent in women than in men, is always polyarticular from the first and often symmetrical. The changes are characteristic. There is an enlargement and flattening of the knuckles and the phalangeal joints, and the fingers are deflected and the movements limited. Then, by degrees, the larger articulations are attacked and more or less crippled by changes in the shape of the ends of the bones. The hand, for example, is flexed and pronated ; the hip flexed and adducted ; and the knee flexed, and sometimes displaced backwards as well by the persistent contraction of the hamstrings. Even the spine and the lower jaw become involved at length. Lips are thrown out round the margins of the joints ; the capsule becomes thickened and rigid in places, thin and yielding in others ; and where the synovial membrane is superficial, as round the patella, irregularly shaped villous outgrowths can be felt gliding on the cartilaginous surface beneath as the joint is flexed and extended.

Minor degrees of this, sometimes causing considerable deformity, are of common occurrence in old people, often without their being aware of it. It seems to be in them rather a result of degeneration than of anything else, and the change is so gradual, and the stiffness comes on so slowly, that they never notice one or the other. In younger patients the course is usually more broken and varied from time to time by subacute attacks, each of which leaves the condition of the joint rather worse than it was before. The affected part is hot and swollen ; the skin is red and rather glazed ; the muscles are in a state of rigid contraction ; and movement is attended with a considerable degree of pain. After a while this subsides and the effusion is partly absorbed, but the change in the shape of the articular surface persists ; the synovial fringes that have grown during the inflammatory period and the marginal lips and bosses do not disappear ; the range of movement is limited partly by the tension of the capsule and the fibroid degeneration of the muscles, partly by the premature locking of the enlarged ends ; and creaking, grating, and crackling of the most varied description can be felt and heard whenever there is the least change of position. In the intervals between these attacks the patient is fairly comfortable ; stiffness of a morning on getting up or after prolonged rest is very common, but this usually wears off in the course of the day, so far as the distortion of the articular surface will allow. Pain is rarely severe, although not unfrequently there is a good deal of aching at night or in cold and damp weather. Every indiscretion in diet is resented at once, but there is no fever or impairment of health other than that occasioned by the inability to take active exercise.

In other cases this disease is distinguished by an enormous collection of fluid in the synovial cavity. This variety is more common in the knee than elsewhere, but it may affect any of the larger joints. In its most chronic form, in which there is simple distension with stretching of the capsule and ligaments, until the bones are forced far away from each other and fluctuation can be felt in every direction, it is known as *hydrops articuli* or *hydrarthrosis* ; there is no increased vascularity; the synovial membrane is slightly thickened and opaque, often rather yellow in colour; the cartilages are a little fibrillated and thinned, and the bones are lipped to a certain extent, but the cavity may be large enough to hold two or three pints of fluid. In some cases the synovial membrane is perfectly smooth; in most, however, it is covered with rough shaggy growths, containing nodules of cartilage, and sometimes the interior resembles a coarse sheep-skin mat rather than the lining membrane of a joint.

This form of osteo-arthritis is frequently complicated with the presence of synovial cysts, which may originate *de novo* as protrusions of the lining membrane of the joint between some of the thicker fasciculi, or may be developed from bursæ. The most common is the one that protrudes between the inner head of the gastrocnemius and the semi-membranosus, and forms a swelling on the inner side of the popliteal space, tense and hard when the limb is extended, but so soft that it can scarcely be detected in flexion; they may, however, develop almost anywhere, at any weak part of the capsule, and in any number.

In the majority of cases osteo-arthritis is polyarticular, but sometimes, especially where the hip is concerned, it remains limited, or almost limited to one joint for years. The bone is the part chiefly affected; the ligaments waste and the capsule becomes rigid; but these changes are very slight in comparison. The neck of the femur may be completely absorbed; the head replaced by a growth of bone springing from just above the lesser trochanter; lips and processes thrown out to such an extent that movement is almost impossible, and the acetabulum enlarged to twice its natural size. The limb is wasted, shortened, and so stiff that it can scarcely be bent at the hip at all; it is the seat of a constant wearing pain; when any attempt is made to use the joint the grating can often be heard some distance away; and the lameness may be so extreme as to disable the patient. This particular variety is most common in old age (whence its name, *malum coxæ senile*), but it sometimes occurs in young subjects after a severe fall upon the trochanter, and then is exceedingly rapid. I have known it already far advanced as early as nineteen; the limb within a twelvemonth of the accident had become atrophied until it was scarcely half the circumference of its fellow; it was an inch and a half shorter, and was everted and fixed to such an extent that it could scarcely be moved; and all this had taken place without any definite family history of gout or rheumatism, or any evidence of such an affection in the other joints. In connection with this particular form it is o great importance to note that the appearance of the limb is practically the same as that of impacted fracture through the base of the neck; but i a definite history of gradually increasing disability can be obtained there i very little difficulty in distinguishing one from the other. Similar change have been known to occur in the case of the humerus, but they are very rar in comparison.

Treatment.—At the commencement, before the effusion has becom organised and definite changes have been produced in the structure of th joint, the treatment of osteo-arthritis may be attended with very satisfactor results. Afterwards little can be done beyond trying to preserve the movement of the part as far as possible and to prevent any further outbreak.

The clothing, not only for the joint itself, but for the whole body, shoul be light but warm; cold and damp are particularly to be avoided. The die should be carefully regulated; sugar, excess of meat, and alcohol seem especially injurious, but in this respect each individual must be a rule for himself. The bowels should be kept regular; the skin should be made to act freely; a Turkish bath may be taken every now and then; and, if possible, a residence in a suitable climate should be selected.

Moist heat, kept up for a considerable length of time each day, and sometimes several times a day, is very beneficial. It may easily be applied to most joints by means of a local vapour-bath; where this is not practicable, flannel, or spongio-piline, wrung out of water as hot as can be borne and covered with oiled silk, may be tried. Greater effect may be produced by combining this with counter-irritants, especially turpentine and tincture of iodine. Flying blisters frequently repeated, hot douches, shampooing, and massage applied every other day, are especially beneficial towards the end of the attacks, when a certain amount of grating and creaking can be felt, and the muscles are beginning to waste. Galvanism may be used at the same time, and passive motion should be carefully and methodically carried out. Nothing is so likely to permanently stiffen a joint affected with osteo-arthritis as prolonged rest.

Iron and quinine are very often required, as in many cases the health fails to a very serious extent; sometimes arsenic agrees exceedingly well, the appetite returning and the strength improving almost at once. Iodide of potash seems to have little real influence, and is sometimes injurious from the depression it causes. Alkalies and colchicum may be tried, especially if there is a strong tendency to gout, but otherwise they are of little avail; and the same may be said of salicylate of soda: sometimes it is beneficial just at first, but this does not last long.

Constitutional treatment, in short, can do little more than maintain the general nutrition and check the tendency to recurrence.

When the effusion in the joint is excessive in amount, an attempt may be made to reduce it by means of counter-irritation and pressure. If this fails, aspiration may be tried, or the injection of tincture of iodine, diluted with equal parts of water. Every precaution must of course be adopted to avoid getting too severe a reaction; the limb must be kept upon a splint, well raised and bandaged, and an ice-bag must be laid over the joint. More frequently the reaction either is not sufficient to excite absorption, or fails altogether; the synovial membrane seems entirely callous. In such a case as this, if the patient is young, requiring to lead an active life, and is incapacitated by the condition of the joint, it may be laid open freely (under proper precautions), some of the redundant synovial tissue excised, the rest scraped out to a certain extent, and then, after the hæmorrhage has been stopped, it may be drained thoroughly, well packed, and placed upon a splint, as after the operation of arthrectomy. The measure is a severe one, and should not be adopted unless the patient is in a perfect state of health, but it has been followed by conspicuous success.

Outlying cysts and diverticula are to be treated on the same principles. It is impossible in the majority of cases to prove that they do not communicate with the joint, and accordingly they must always be given the benefit of the doubt. Sometimes, but very rarely, they are absorbed under the influence of counter-irritants, and cause no further trouble. More frequently they can be prevented from increasing by means of suitably arranged pressure. If this fails, aspiration may be tried first; but, if in spite of this, the cyst persistently enlarges, causing a serious degree of weakening, and practically disabling the patient, it should be excised. I have performed this operation on several occasions at the knee, removing the bursa which projects between the inner head of the gastrocnemius and the semi-membranosus, and stitching up the neck of the communication with catgut, and the result has been very satisfactory. Unfortunately, in many of the cases in which cysts form, the disease is so extensive that this is practically out of the question.

Charcot's Disease

The most peculiar form of osteo-arthritis is that which occurs in association with affections of the nervous system, especially locomotor ataxy, and which is known as Charcot's disease, from the physician who first described it. So far as their general features are concerned, the pathological changes are of the same description as those that occur in other forms of osteo-arthritis, but the rapidity with which they set in, the extent to which the destruction is carried, and the entire absence of pain (at any rate, in the vast majority of the cases recorded) stamp it at once as something that must stand by itself. What relation it bears to the ataxy is an entirely different question. When it occurs (and it is only present in a relatively small pro-

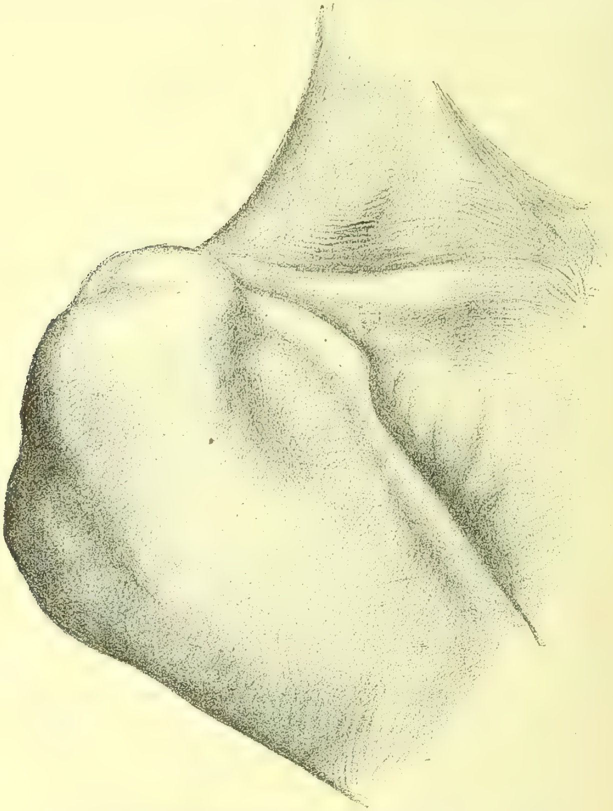


Fig. 230.—Shoulder-joint from a case of Charcot's disease.

portion) it usually breaks out at an early period of the disease, when the first signs are scarcely marked; and I have known a typical example of it in a patient in whom at the time the closest investigation did not reveal anything but local anæsthesia. Similar affections have been met with in other diseases and injuries of the nervous system, though much more rarely. It has been recorded in hemiplegia, in paraplegia from Pott's disease, in poliomyelitis, and in two instances, at least, in wounds of the spinal cord; and osseous anchylosis of the finger-joints has been known to follow section of the nerves of the forearm. It is not at all improbable that it is really associated with the changes in the peripheral nerves rather than with any special disease of the central nervous system, though, of course, if it occurs in connection with the one, it may also occur in connection with the other.

Whether, again, it should be regarded as a special disease, caused by impairment of nerve-influence, or merely as rheumatic gout, occurring in a joint which has lost all sensation (so far as pain is concerned), and which, therefore, is very likely to be subjected to the most injurious degrees of violence, is also an open question. Pain is present, it is true, and is very acute in a small minority of cases, but, as a rule, it is soon followed by anæsthesia; and even when it does occur it does not appear to bear the same relation to the severity of the inflammation that might be expected, judging from what is usual in other forms of arthritis; it seems something altogether peculiar, dependent upon the changes taking place in the nerves themselves, rather than upon the degree of tension in the tissues of the joint. Too much reliance, therefore, must not be placed upon that. It is more important, however, that this disease has been known to occur in patients while they were confined to bed. That walking about upon a knee-joint, devoid of all sensation, in which the ligaments have given way and the bones are so soft that they would literally be ground down by the least pressure, would produce very extensive changes, similar in many respects to those actually met with, may be admitted at once; but if it can be clearly established that the same effect follows sometimes when the joint is kept practically at rest, the theory that the destruction is due to the injury, as in the case of perforating ulcer, must break down. The analogy between the two cases is very distant; perforating ulcer nearly always gets well of itself if the foot is placed under favourable conditions; this form of joint-disease, when it is once thoroughly declared, never attempts anything of the kind. It proves nothing, one way or the other, that the ordinary form of rheumatic gout may occur in patients suffering from locomotor ataxy.

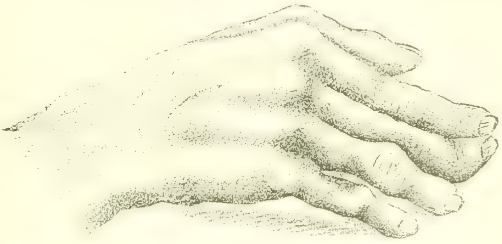


FIG. 231.—Fingers of the same patient.

The knee-joint is affected far more frequently than any other. Suddenly, almost from one day to another, without warning of any kind, except, perhaps, a certain amount of grating, an immense swelling makes its appearance, partly due to effusion in the joint, partly to the œdema of the surrounding soft tissues. Sometimes with this there is a certain degree of fever and pain, and the skin is hot and red; but this soon subsides and suppuration very rarely occurs. The outline of the bones is completely lost, the swelling is globular, tense and resistant, scarcely pitting on pressure; movement is attended with grating, and the joint is loose, so that the articular surfaces can be shifted in all directions; but still the patient can use it to a certain extent, especially as it is usually entirely free from pain. Then, after a time, the effusion becomes absorbed or organised, the swelling diminishes in size, and hard nodules, due to the formation of cartilage or dense fibrous tissue in the periarticular tissue, make their appearance. The articular ends of the bones disappear, the ligaments become softened or worn away; crepitus, as of two fractured surfaces, is felt when the part is manipulated; movement can take place in any direction: the leg, for example, can be extended until it lies flat upon the anterior surface of the thigh; the patient loses all power, and the most extreme distortion follows (figs. 230. 231. and 232).

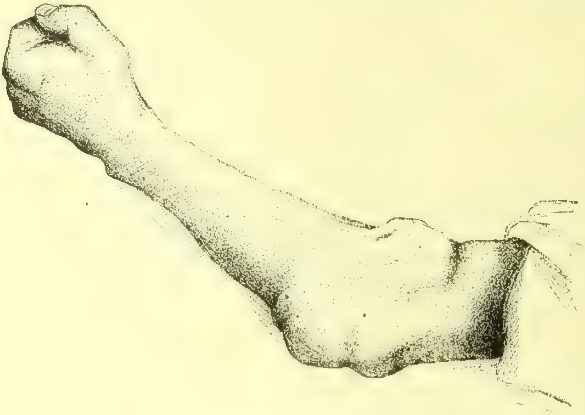
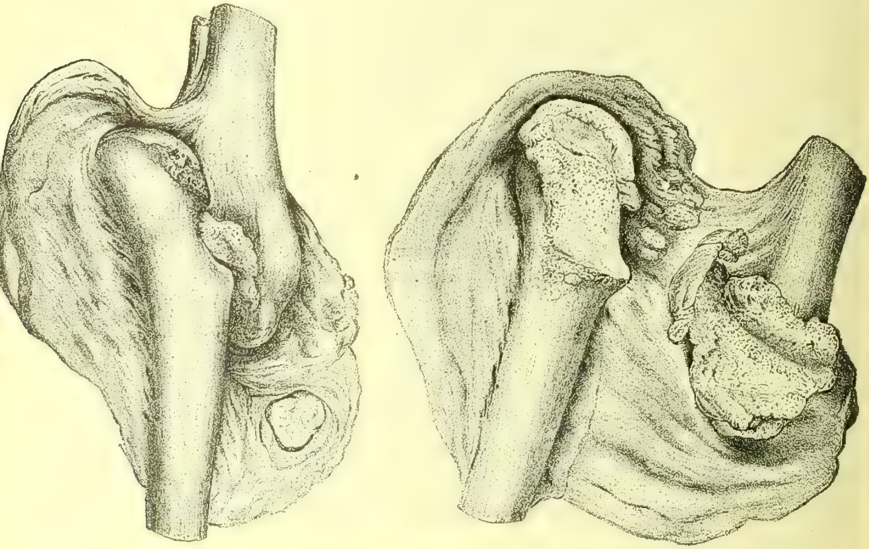


Fig. 232.—Elbow-joint from a case of Charcot's disease.



Figs. 233 and 234.—Knee-joint from a case of locomotor ataxy (Morrant Baker's case).

The pathological changes are the same as those that take place in osteo-arthritis; there is chronic inflammation of all the tissues of the joint with atrophy, only this is extreme. The cartilages become fibrillated and disappear; the ligaments are softened and worn away; the bones are affected with rarefying ostitis, so that spontaneous fracture is not uncommon; the surrounding tissues are filled with inflammatory exudation, which sometimes becomes organised, so that osteophytes and free bodies and occasionally great lips of bone are formed; but there is rarely any eburnation, and the ends of the bones seldom show that adaptation to each other which is so common a feature of rheumatoid arthritis; the destruction is so great that they are reduced to two rounded sticks, one of which may fit to some extent in a hollow on the top of the other, but which not uncommonly simply lie side by side, so that the limb is shortened by many inches, and the joint is reduced to the condition of a flail (figs. 233 and 234). In many instances the amount of destruction falls far short of this; but striking examples have been recorded in which the ends of the bones have entirely disappeared, and the joint been completely disorganised within six weeks.

Tubercular Arthritis.

Tubercular infection of joints gives rise to a peculiar and characteristic form of inflammation which in all respects closely resembles that caused by the presence of tubercle in other parts of the body. It is much more common in children than in adults, although it may occur at any time of life (even old age is not exempt); it begins in the most insidious way; sometimes there is a distinct history of injury; more often nothing definite can be ascertained; occasionally every such cause can be positively excluded, as when, for example, a child lying in bed with caries of the spine is found to have developed disease of the hip; its progress is exceedingly slow, and although it may subside at any time, the tendency is to run on to the formation of a lowly organised granulation-tissue, which, as it spreads wider and wider, gradually undergoes caseous degeneration in the centre, breaks down and liquefies, forming what is known as a caseous abscess. It is identical with what was formerly described as strumous or scrofulous synovitis and arthritis. The general resemblance between the clinical characters and the main pathological features of strumous disease of joints and tubercular affection of other organs had long been recognised: it was well known that they often occurred together; that the same circumstances favoured their development; that caseous foci were present in both; and that in many cases of primary joint-disease the lungs and other organs become affected later with typical miliary tubercle; but it was not until the discovery and cultivation of the tubercle-bacillus that the identity was established and confirmed beyond all question by experiment.

The inflammation either begins in the synovial membrane or the bone: cartilage and ligament are probably never involved first. The bacillus enters the body through the mucous membrane of the alimentary canal or of the respiratory tract, rarely through a wound. Sometimes apparently it is arrested in the lymphatic glands and retained until its vitality is lost; in other instances it passes through them, or infects them one after the other until it gains the larger trunks and enters the blood-stream; or again it merely causes a local inflammation, which is scarcely noticed, so slight are the symptoms, until some trivial injury wakes it into life, and perhaps, by rupturing some of the small vessels, forces the caseous mass at once into the general circulation. In any case it is brought at length to the more vascular parts of the joint where the blood-stream is quickest and where, owing to the rapidity of their growth, the tissues are least capable of resisting its influence.

Even then its action may be averted. If the dose is small and if the tissues are healthy, there is no doubt that very often the germ is either destroyed or encapsuled, or got rid of in some other way, so that no harm results. The younger the patient and the younger the tissue the greater the danger; and if, either from some hereditary or acquired cause, the nutrition of the part is feeble; or if, from some recent injury, there is an extravasation of blood, surrounded by a mass of recently formed granulation-tissue, the bacilli may continue to grow and spread wider and wider, until at length a group of miliary tubercles is formed, and caseation sets in. In children the synovial membrane and the growing portions of the bone are involved with nearly equal frequency, so that in them primary tubercular synovitis is as common, or nearly as common, as tubercular articular ostitis; in adults, on the other hand, in whom the bones have attained their full development and have lost their embryonic tissue, the former is much more common than the latter. Injury, although it is not essential, must be regarded as a very decided predisposing cause, not only from the hyperæmia that attends it, but because the inflammation that follows lowers the vitality of the tissues and renders them less capable of resistance. The same may be said of the exposure to cold and wet and the exhaustion, which are not unfrequently considered the starting-points of a distinctly tubercular affection.

Pathological appearances.—(*a*) The changes that take place in the synovial membrane are the same, whether the inflammation begins in it or spreads to it from the bone, although of course in the latter they make their appearance later and are to a certain extent masked by the rest.

The softer and more vascular parts, such for example as the folds in the interior of the knee-joint, are affected first. The endothelium is detached; the surface loses its glistening appearance; the areolar tissue becomes soft and melts away; lymph pours through the walls of the vessels and the exudation increases, until at length the membrane is replaced by a soft gelatinous pinkish-grey mass of granulation-tissue many times as thick, and very ill supplied with blood. In this, typical miliary tubercles may be found here and there, and, though often only after a long search, tubercle-bacilli. As the exudation becomes more abundant it forces its way between the surrounding structures in all directions. It grows into the cavity until this is nearly obliterated; it spreads on the surface of the cartilages, eating them out in little circular pits, until the bone beneath is exposed, to be attacked in turn; and it works its way through the capsule, and spreads in the loose tissue around, until the shape of the synovial sac is entirely lost, and the swelling is perfectly uniform in outline and consistence. In some cases the joint is surrounded by a mass of this gelatinous tissue upwards of an inch and a half in thickness.

As time passes further changes make their appearance. The fluid in the interior loses its synovial character, and becomes more and more turbid until at length it resembles pus. The dense fibrous tissue of the capsule and ligaments becomes infiltrated with the growth and softened, so that the ends of the bones are no longer held together, and displacement follows. Caseation occurs in the thickness of the granulation-tissue ; and finally liquefaction takes place. Sometimes the abscess, as it is usually called, points on the exterior and bursts, leaving a sinus guarded at the orifice by a mass of pale, flabby granulations, and leading down into the thickness of the gelatinous tissue ; sometimes it opens into the joint as well, and after a while suppurative arthritis is added to the rest.

(*b*) When the inflammation begins in the bone, the pathological appearances are somewhat different. It may start in the epiphysis or on the articular surface of the diaphysis (fig. 235) ; but invariably it attacks the part where growth is most rapid and the blood-supply most active. Sometimes the onset is very insidious : one or two hyperæmic spots make their appearance by the side of the epiphysial cartilage ; rarefying ostitis sets in ; masses of fungating granulations are formed ; and the bony trabeculæ are absorbed, until, if the disease spreads laterally, the epiphysis may be completely detached from the shaft. More often it spreads towards the articular surface and gradually works its way until it reaches the cartilage that covers the end of the bone (fig. 236). In a little while this is either absorbed, eaten away from beneath, or detached in great flakes, and then the granulations sprout into the synovial cavity, infecting the surface all the more rapidly because of the previous irritation. Caseation, as a rule, follows sooner or later, and then liquefaction ; sometimes, however, they never occur, and large portions of bone or even whole bones are removed and replaced by soft granulations without any abscess ever being formed.

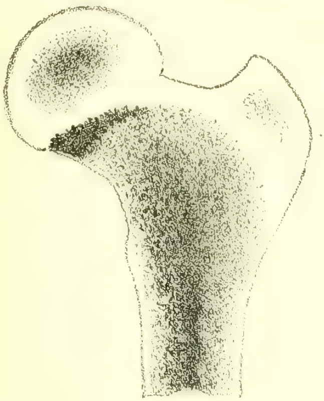


FIG. 235. — Femur, showing the commencement of tubercular disease under the neck of the bone on the upper surface of diaphysis.

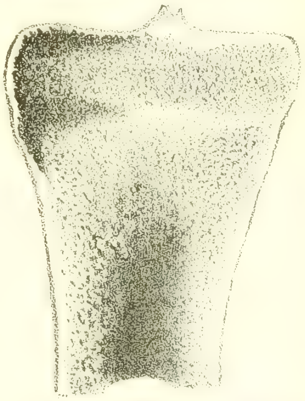


FIG. 236.—Tibia, showing tubercular disease advancing from the epiphysial line, round the edge of the epiphysis to the under-surface of the articular cartilage, which it is gradually eroding.

In other cases the inflammation is more acute ; sequestra of a peculiar conical shape are formed, the base covered with articular cartilage, the apex lying near the centre of the epiphysis ; suppuration occurs at an early period, and destructive arthritis is soon added to the rest. Probably, as has been pointed out by Koenig, these cases are due to embolism ; a mass of tuberculous material is set free from some distant focus and carried into one of the nutrient branches until it becomes impacted, and the whole area supplied by that vessel perishes (fig. 237).

In the later stages, and after suppuration has set in, the result is much the same, wherever the disease commenced. The articular cartilages are removed by sloughing or absorption; the bones are exposed, eroded and carious; necrosed fragments are present here and there in the pus that surrounds them; the ligaments are destroyed, so that displacement or even dislocation is allowed; and the synovial membrane, the capsule, and the peri-articular tissues are converted into a soft gelatinous mass, in which a few fibres can still be found mixed with caseous débris and pus.

Repair.—Repair and organisation of the exudation are possible at every stage, and it rarely happens, even in the worst cases, that no trace is to be found. (*a*) Before caseation has taken place recovery may be almost perfect; the tubercular masses are either absorbed or encapsuled; dense fibrous tissue, or, if they lie in the bone, a ring of sclerosis forms around them, and, unless roused into activity again by injury or some other accidental cause, they may remain quiet for the rest of life, and gradually undergo degeneration, leaving merely a little stiffness or weakness behind.

If, however, the disease is more widely spread—if, for example, the whole of the synovial membrane is involved, or part of the bone has undergone necrosis—such perfect repair can scarcely take place, though, still, if the health improves and the tissues are better nourished and better able to resist infection, the joint may be saved, stiffened to a certain extent from the masses of fibrous tissue formed around and inside it. Such cases are not uncommon in children. It is well known that the tuberculous tendency, when the joints are concerned, is of limited duration. As puberty is reached and the period of active growth gives way to that of mature organisation, the tissues lose their susceptibility to its influence, and the inflammatory process comes to an end, repair setting in sometimes almost suddenly. It is by no means unusual to meet with adults, apparently strong and healthy themselves, yet bearing very manifest traces of extensive disease from which they suffered in childhood.

(*b*) Even when caseation has occurred and the centre of the mass has undergone liquefaction, so that a large cold abscess is formed, repair is still possible to a certain extent. The abscess is bounded by a layer of granulation-tissue thrown out by the surrounding structures, which are constantly striving to protect themselves against the invading tubercles. Sometimes these cease to extend; the liquid portion of the mass is slowly absorbed; the residue becomes encapsuled, perhaps calcified; the surrounding granulation-tissue grows hard, dense, and fibroid, and the disease comes to an end; but the chances of this are much more remote.

(*c*) If suppurative arthritis follows, recovery without anchylosis is practically out of the question: generally it is osseous; the cartilages are destroyed, the granulations that spring from the ends of the bones gradually obliterate the synovial cavity and are converted into bone. Sometimes, however, it remains fibrous, and a certain though very limited degree of mobility is allowed. The rest of the limb in these cases usually suffers very severely; the growth is checked, the muscles are wasted, the skin is riddled with sinuses or disfigured by deep sunken cicatrices; residual abscesses occur from time to time in the old scar-tissue, and often there is great deformity from the displacement or dislocation of the ends of the bones.

Hectic and amyloid degeneration may occur as complications at a later period, brought on by the profuse and continuous suppuration. Phthisis is rare, but tubercular meningitis is not at all uncommon. It may occur at any period of the disease, but in the majority of cases it breaks out either at the commencement of suppuration or when the caseous foci and the granulations surrounding them are disturbed by some accidental violence, such as over-exertion, or by operation. The frequency of its occurrence is one of the main arguments for the free and early removal of the caseous mass, even if it involves excision, as it nearly always does in the case of the hip.

Symptoms.—Pain, heat, and swelling are always present, although they vary very much in degree ; the skin is never red, unless suppuration has taken place ; on the contrary, owing to the way in which it is stretched by the exudation beneath, it is not unfrequently peculiarly white and marked with enlarged cutaneous veins—whence the name, *tumor albus* or *white swelling* often given to this form of joint-disease.

The pain is very variable. When the inflammation begins in the bone, it is often an early symptom, and, like all bone pain, is worse at night and after exertion. Moreover, under these conditions, starting-pains soon make their appearance, and the bone is often exceedingly tender on pressure. On the other hand, in tubercular synovitis, it may be entirely wanting, and the joint may attain a very considerable size, and even displacement occur from softening of the ligaments, without there ever having been more than a transient complaint.

Increased temperature is much more constant, although the rise may be very slight, and, especially in the case of a deeply-buried joint such as the hip, very difficult to estimate. Great care must be taken in examining the two limbs that exactly the same spots are compared, that they are both exposed the same length of time, and that one has not been unduly manipulated.

The character and situation of the swelling are most important. In tubercular synovitis it causes a soft uniform enlargement of all the superficial parts, so that the bony prominences are concealed and the outline of the limb is even and rounded. In the knee there is at first merely a slight fulness on either side of the ligamentum patellæ ; then the hollows by the side of the patella are filled up, and the subcrural pouch is converted into a soft rounded mass, which stands out all the more prominently from the wasting of the quadriceps above. In the elbow, the swelling shows itself first on either side of the triceps tendon, and in the ankle by the tendo Achillis. In the hip it is much more difficult to estimate, but by flexing and abducting the thigh as far as the patient will allow, the hollow of Scarpa's triangle can be mapped out distinctly and the least elevation detected. There is no increase in the amount of fluid ; the swelling is soft, elastic, perfectly uniform in consistence, and conceals every bony projection and every prominent ligament and tendon.

In articular ostitis, on the other hand, at least in the early period before the joint-cavity is involved, the shape is much less uniform. The swelling does not follow the outline of the synovial sac ; it spreads up over the periosteal surface of one of the bones ; and very often it is limited or nearly so to one side of the joint ; moreover, it is firmer and more uneven in consistence, and not unfrequently it is exceedingly tender.

Impairment of the function of the part is one of the earliest signs. The range of movement is restricted, leading in the lower extremity to lameness.

Flexion is more free than extension, but neither is allowed to its full limit; and as the disease advances this becomes much more marked. The position of the limb is altered; the hip is flexed and adducted; the knee flexed and rotated out; the ankle more or less extended; and, especially in the case of the two former, this movement may in the later stages of the disease be carried to its utmost limits. At first, the flexed position is assumed voluntarily as that which gives the greatest ease; but afterwards it is kept up and exaggerated by the spasmodic contraction of the flexor muscles; and ultimately, when the ligaments are softened and the articular surfaces worn away, it ends, if left to itself, in pathological displacement and dislocation.

Muscular wasting or loss of tone is rarely absent. Usually it affects the extensors; thus the flattening of the buttock is one of the earliest, and, because it cannot be imitated, one of the most valuable signs of hip-disease; but it may involve all the muscles of the limb, so as to cause a diminution in the general circumference. In the shoulder, the deltoid and supraspinatus suffer first; in the knee, the quadriceps; and in the ankle, the muscles of the calf.

The constitutional symptoms at the beginning are very insignificant. Later, when starting-pains make their appearance, and when the synovial swelling increases in size, there is a certain degree of fever, especially of an evening, the appetite fails, and health and strength begin to give way. If the case is left to itself, and abscesses are allowed to form and break, the downward progress becomes more and more rapid. The patient is worn out by the constant pain and want of sleep; there is a continuous and often profuse discharge of pus from the sinuses round the joint; the temperature is constantly above normal; night-sweats set in in a very large proportion of cases; and the patient sinks from hectic or amyloid disease, or else tubercular deposits make their appearance in other organs.

Diagnosis.—The diagnosis of tubercular arthritis in the early stages of the disease is often a matter of the greatest difficulty; the swelling may be of the most insignificant character; the pain very doubtful (and especially in the case of children often stigmatised as merely growing-pain); and the temperature scarcely raised; but these symptoms and muscular wasting very rarely fail altogether. It is distinguished from all other forms of arthritis by the peculiar insidiousness of its attack and by its obstinate tendency. It is much more common in the young than in the old, but it may appear at any period. Even when it starts from an injury, it does not, like ordinary traumatic synovitis, follow at once; it may be months before anything definite is found; and it very rarely happens that it is possible to assign even an approximate date for its commencement. If other symptoms of scrofula are present (chronic glandular enlargement for example, obstinate pulmonary or nasal catarrh, or persistent dermatitis), the probability is no doubt very much greater; and the same may be said when either there is a distinct family history of tuberculosis, or when the aspect of the patient is such as to suggest the peculiar diathesis that predisposes to it; but, beyond all question, tubercular arthritis (though of course, unless it is due to a wound, it must be a secondary affection, spreading from some other part of the body) may occur in the absence of any other sign of such a disease, and without any manifest predisposition to it.

Prognosis.—Many things have to be taken into consideration in the prognosis of tubercular arthritis. The family history, the evidence of a special diathesis, and particularly the presence of any other scrofulous or tubercular affection are of very great importance. The more distinct and well-defined the exciting cause the better: those cases are peculiarly ill-omened in which, while the patient is confined to bed, one of the joints becomes affected without its being possible to assign a reason. The period of the disease again is of very material influence; there is much better hope before caseation has commenced; if suppuration has once occurred, recovery is not only more doubtful, and the tendency to secondary complications much greater, but the prognosis, so far as the joint is concerned, is very decidedly worse: more or less anchylosis must follow. A great deal depends upon the circumstances of the patient, whether he can afford the necessary time and the necessary treatment. The statistics drawn from private practice, and, as Howard Marsh has shown, from institutions in which an unlimited stay is allowed, are entirely different from those of general hospitals, into which patients can only be admitted for a short time, until the severity of the immediate symptoms has subsided. Fortunately, tuberculosis of joints is in most cases a disease of early life: as puberty approaches, the tendency to chronic inflammation and caseation subsides; and even though the disease has reached an advanced stage, and suppuration has occurred, the sinuses not unfrequently dry up, the carious bone becomes dense again, the granulation-tissue becomes organised, and the joint is left distorted, misshapen, seamed with cicatrices, and permanently anchylosed, but safe, under all ordinary conditions, for the rest of life.

Senile Tuberculosis

During adult life tubercular arthritis is not a common affection, although instances of it may be met with every now and then, originating in the synovial membrane. After sixty years of age, Paget has shown that the bones, joints, lymphatic glands, testicles, and other structures which appear to be the seat of election of scrofula in the young, again become liable to a similar affection. In all probability, this is due to a local tuberculosis, in the same way as the ordinary strumous or scrofulous joint-disease of childhood; certainly it is in a very large proportion of the cases. There is the same insidious beginning, the same soft, pulpy swelling around the joint, leading to the smooth uniform enlargement characteristic of tuberculous synovitis; there is the same tendency to softening of the ligaments and displacement of the ends of the bones, but, as might be expected from the diminished reparative power of the tissues, the risk of suppuration and destruction is very much greater. Abscesses form at an early period, and discharge themselves externally, leaving sinuses lined and covered with pale flabby granulations; the cartilages slough, the bones become exposed and carious, so that a probe introduced into one of the sinuses sinks deeply into their substance, and in a very short time, compared with what takes place in young subjects, the joint is hopelessly disorganised.

Treatment.—The general treatment of tubercular arthritis, so far as the early stages of the disease are concerned, is perfectly definite. There is no doubt it is parasitic in its origin, and everything is good that tends to increase the resisting power of the tissues or check the growth of the infection. If only sufficient time can be gained, and maturity reached, without the disease having extended too far, there is every hope of recovery.

Good food, fresh air (preferably at the seaside), cod-liver oil, iron, quinine, tonics, &c., are the chief hope for improving the general nutrition. Absolute rest, until every trace of tenderness, swelling, and muscular rigidity has departed, cold, compression, and, to a much less extent, counter-irritation, are the main local measures. Heat, and everything that tends, like use or exercise, to increase the amount of blood flowing through the part, are positively injurious. The injections of carbolic acid (which are strongly recommended by Hueter) and other germicides are of very doubtful value. If a sufficient length of time can be given up to this treatment; if the rest is absolute, upon a splint; and if the disease is taken at a sufficiently early period, recovery without loss of health, and without stiffness of the joint, may be confidently looked forward to, in all but a few cases in which the constitutional predisposition is overpowering.

When the disease is farther advanced, especially if the joint has had a fair trial and has relapsed; when the synovial membrane is obviously becoming thicker and more pulpy in spite of prolonged rest under the best available circumstances; and when the persistent local pain renders it practically certain that there is a focus of disease in one of the epiphyses, the question arises whether it is not advisable to treat it as a locally malignant disease, lay the joint freely open, and excise the whole of the affected part. This operation is known as *arthrectomy*, when only the diseased portions are removed, and as *excision* when the articular ends are formally resected in accordance with the rules laid down by the anatomy of the part. The former is practically limited to the knee; in the hip and ankle it is almost impossible to expose the whole synovial surface, and in the elbow it does not give sufficient mobility.

That arthrectomy, where it is practicable, is to be preferred to excision, is beyond question. The growth of the limb is not affected; tubercular foci may be scraped out without interfering with the epiphyses; the length is not altered; if the disease is removed before the cartilages are seriously affected, a great degree of movement is retained; and it is practicable in the youngest children, while excision is not. It is true that a certain amount of support is required afterwards to prevent flexion, but this is the case in excision as well.

Nor is there any doubt that in advanced disease, where there is extensive caries or necrosis, or where there are many sinuses leading down through masses of pulpy tissue to a disorganised joint, excision of a more or less formal character is advisable, practically as an alternative to amputation.

The real point at the present day is whether arthrectomy, or, failing that, excision, should be performed at an earlier period in tubercular arthritis, as an alternative to rest, as soon as caseation has made its appearance, long before the abscesses have broken externally, and the case has become complicated by the addition of suppurative arthritis.

On the one hand there is a caseous focus with the prospect of liquefaction, possibly ending in suppurative arthritis or general tuberculosis, possibly, after protracted treatment, becoming absorbed as the patient gets older, but leaving the limb withered, shortened, wasted, perhaps seamed with cicatrices, and more or less anchylosed.

On the other we have an operation which may shorten and impair the growth of the limb, but which should, if successful, allow the patient to get about within two or three weeks, or months at the most, and render him ree for the rest of life from the danger of tubercular infection. At the same ime, it must be admitted that there is a certain, though slight, risk ; that here is some danger of septic arthritis; and that there is a possibility of ome of the caseous material being driven into the circulation during the ourse of the operation, and causing thereby the very ill it is intended to void. That this is not imaginary is proved by the fact that at least ten per ent. of the deaths after operations of this kind are due to acute miliary uberculosis.

At present the evidence is not sufficient to settle the question one way r the other. Probably if the treatment were begun sufficiently early and arried out sufficiently thoroughly, and for a proper length of time, it would ot arise at all. Unhappily in the majority of patients that apply to hospitals he disease is far advanced and is months old already.

Rest must certainly be tried thoroughly first. Whether, if it has failed nce, it should be repeated, in the hope that the patient will be able to live own the bacillus, must depend to a great extent upon the joint involved nd the condition of life. In the case of the hip, for example, unless two or hree years can be given up absolutely, under the best conditions, the treatnent must not be blamed for the result. Operation is certainly advisable vhere, as in the case of the knee, and sometimes the ankle, it is possible to lear out a caseous focus from the interior of the bone, without the articulaion being seriously involved ; and there is no doubt that the results, so far s the healing of the wound is concerned (primary intention is absolutely ecessary) have improved immensely with greater experience as to what is equired ; but it has not yet been proved that the ultimate results of more xtensive operations, especially in the case of the hip-joint, are very far uperior, either as regards mortality or utility, to those of the expectant lan, and although it is admitted that they are necessary in many cases, hey cannot be recommended for general adoption.

Cold abscesses may be drained, or, if they are moderate in size, treated in he way recommended by Barker. The fluid is drawn off with a hollow eedle and an emulsion of iodoform in glycerine thrown in ; this by virtue of ts high specific gravity, sinks into the deepest part of the tuberculous cavities nd even penetrates through the thick deposit of caseous matter. Others ave employed a five per cent. solution of the same drug in ether ; but are must be taken, if the abscess is of any size, not to cause iodoform-oisoning.

Relapses are of common occurrence, whether tubercular arthritis is treated y prolonged rest or by operation. Some of these are true relapses, due to he death or removal of the tubercle-bacilli having been incomplete, and to the onditions that favour their growth having suddenly been revived : a sprain, r example, causing slight hyperæmia, may wake into activity again the erms that are lying latent in an old tubercular joint ; but not improbably, specially when they take the form of residual abscesses, many of these are ierely due to the imperfectly nourished scar-tissue breaking down from some ccidental cause, and do not imply a return of the specific disorder.

Arthrectomy.—By this is understood the complete removal of all the iseased structures from a joint without interfering more than is absolutely ecessary with the growth or the length of the limb. Practically it is imited to tubercular disease of the knee-joint, though in exceptional cases it nay be performed upon the hip or ankle. As the amount of movement retained afterwards is in most cases limited (it depends of course upon the extent of the disease) it cannot compare with excision of the elbow or shoulder.

The line of incision varies with the locality of the disease. Where there is a distinct enlargement of one of the condyles, without the synovial membrane being much thickened, a longitudinal incision down the side of the joint is sufficient. If, on the other hand, the mischief is more extensive, the whole of the interior of the articulation must be thoroughly exposed. This may be done either by a transverse incision across the patella, the two fragments being wired together afterwards; or better, by the old-fashioned semicircular incision for resection, carried a little farther down over the tubercle of the tibia. This projection of bone can be separated from the shaft with a stout scalpel (it is part of the epiphysis and remains for a long time cartilaginous), or, if it is bony, with a chisel, and then turned upwards with the patella on to the femur. A single median longitudinal incision dividing the patella vertically, does not allow the sides of the joint to be examined; but, if the disease is not far advanced, it is probable that sufficient space may be obtained by two, one on each side, without a transverse one, and without dividing the ligamentum patellæ, as recently practised by Sendler.

As it is very important to prevent oozing after the operation, Esmarch's bandage is not used, but the limb is raised vertically for a few minutes after Lister's plan, and the circulation controlled by an elastic tourniquet. Experiment has shown that the presence of coagula under these conditions is distinctly favourable to the development of miliary tubercle, and interferes with primary union. So far as possible the diseased structures are dissected out, cutting through the healthy tissue outside them: crushing or bruising them in the process is liable to force some of the caseous débris into the open vessels, especially where the bone is exposed. The thickened synovial membrane, for example, after the flap is reflected, is carefully dissected off the under surface, commencing at the top, and passing completely round the reflection under the crureus on to the surface of the femur. The sides are treated in the same way, the crucial and posterior ligaments being thoroughly cleaned, but, if possible, preserved intact. Sometimes a sequestrum is found and can be removed: but, as a rule, if the bones are involved, a gouge must be used to scoop out the soft caseous material, and the infiltrated cancellous tissue around. For this Barker recommends a hollow instrument connected by a rubber tube with a receiver, as by it the débris can be washed away from the surface of the wound at once.

After the whole interior has been thoroughly examined, the bleeding points are secured (they can easily be seen by relaxing the tourniquet for a moment), all oozing stopped by flushing the wound with a solution of iodine or corrosive sublimate in water as hot as can be borne, and the stitches inserted, a sponge being left in until they are all in position. The surface may be dusted with iodoform, if it is not too extensive, or brushed over with a solution of the same drug in ether. It is believed, though perhaps on insufficient evidence, that it has some special action on the tubercle-bacillus. Kocher recommends, in the case of the shoulder, that the cavity should be filled with iodoform-gauze, and left for three days, before the sutures are fastened up, so great is the importance of preventing extravasation and keeping the wound dry.

Drainage-tubes are advisable, although their presence necessitates the dressing being changed sooner than may otherwise be necessary. The joint is carefully packed with an absorbent dry dressing, the edges of the wound not being covered by the first layer, so that if any fluid is secreted it is forced out through the lips at once; and then fixed on a splint or with a plaster bandage, and kept absolutely at rest. For the first twenty-four hours it should be raised to the vertical position if possible, in order to check the flow of blood and to diminish the chance of oozing. Afterwards the dressings are changed when required, but, as there should be no discharge, they may often be left for a fortnight.

A splint must be worn afterwards until the growth of the limb is complete.

DISEASES OF SPECIAL JOINTS

Disease of the Hip

Tubercular arthritis of the hip is much more common in children than adults, a very large proportion of the cases occurring between five and ten years of age. Usually there is a history of injury, or of exposure to cold and wet, or of some specific fever, generally measles; but in the vast majority it is impossible to trace a direct connection.

Pathology.—Disease of the hip, in children, almost always begins in the bone; sometimes, especially in older patients in whom growth has nearly ceased, it commences in the synovial membrane, but probably never in the ligaments or cartilages. The appearance of ulceration, so often described on the latter, is really due to absorption by the granulations springing from the bone; and the hyperæmia and softening of the round ligament which are still more common, are accounted for, partly by the development of the collateral circulation, partly by the early extension of the inflammation. The head and neck of the femur lie entirely within the capsule, so that inflammation involving the growing part of the bone must implicate the synovial cavity within a very short time.

In a small proportion of cases the disease starts in the acetabulum, probably in connection with the **Y**-shaped epiphysis; but according to Wright, in 90 per cent. of those subjected to excision, the head or neck of the femur was the part first involved. In upwards of half, however, the acetabulum was superficially diseased.

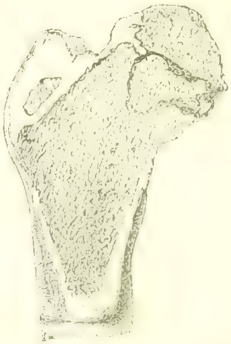


Fig. 237.—Sequestrum on under surface of neck of femur.

The favourite locality is on the under surface of the neck of the bone, on the articular side of the diaphysis; probably this is the part upon which strains fall most frequently, or it may be due to the fact that most of the vessels enter here. In some cases, especially the more acute ones, there is a sequestrum such as might be caused by tubercular embolism (fig. 237); in others, there is a layer of characteristic grey granulations spreading quietly along the growing bone, and undermining the epiphysis. Sometimes the osseous nucleus of the head is almost unaffected; sometimes granulations spring up in it as well, and gradually eat away the articular cartilage from beneath. The trochanteric epiphysis, on the other hand, is very rarely involved.

The earlier changes are seldom seen. If the treatment is commenced at once and carried out thoroughly, the soft granulations become organised, the tubercular deposit is absorbed or encapsuled, and complete restoration takes place.

As the disease advances the synovial membrane becomes thickened, softened, and vascular, although it very rarely shows such complete pulpy degeneration as it does in the knee. The fluid in the joint is turbid, with flakes of lymph and fragments of cartilage. The firm, fibrous parts of the capsule are affected least; the soft and delicate structures attached to the posterior intertrochanteric line, and the loose mass that fills up the cotyloid notch, suffer the most. In some cases the head of the bone is completely separated, almost unchanged, and lies as a loose sequestrum in the interior (fig. 238); in others, when the joint is opened the articular cartilage is hanging in shreds, loosened and detached by the granulations springing from the bone beneath; the osseous centre is eroded, carious, and greatly reduced in size (fig. 239); and no trace of ligamentum teres can be found.

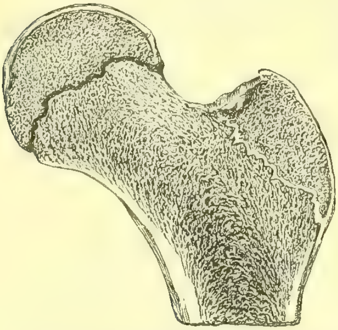


FIG. 238.—Separation of head of femur as a sequestrum.

The acetabulum fares no better, even when the disease is femoral from the first: the disease spreads along the synovial folds: the cartilage is partly eaten away by the granulations springing from the femur, partly detached by those growing from the base beneath; the bone is exposed and carious; sometimes there are sequestra here and there; and not unfrequently, especially in old, neglected cases, the cavity is enlarged upwards and backwards from the pressure of the head of the bone in extreme flexion.

The neck of the femur may be shortened by caries eating into it from the epiphysial surface, but it usually acts as a barrier. Sometimes, however, the disease spreads down it, gradually absorbing the cancellous tissue in the interior, and replacing it by a mass of caseating granulations, until at length the medullary canal of the bone is reached, and chronic tubercular osteomyelitis is added to the rest.

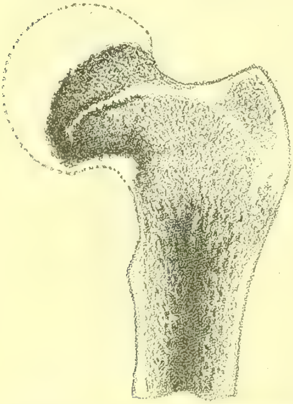


FIG. 239.—Advanced tubercular disease of head of femur, showing the extent and direction of the destruction.

Later, as the caseous deposit begins to liquefy and break down, the inflammation spreads from the capsule to the periosteum covering the upper part of the shaft. Caseous abscesses make their appearance around the joint; sometimes they occur independently, originating in the soft and gelatinous periarticular tissue; sometimes they are due to the inflammation in the bone working its way to the surface outside the attachment of the capsule. Then the skin and the tissues around become undermined; the caseous deposits extend until they either break of themselves or are opened; and true suppurative arthritis sets in as well.

When this occurs, the process of destruction proceeds at a much more rapid rate: portions of the acetabulum undergo necrosis; the floor is perforated: large intrapelvic abscesses form; the rim is destroyed; the cup-shaped cavity is immensely enlarged, especially upwards and backwards, the direction in which it is subjected to the pressure of the femur; the cartilages disappear; the ligaments are softened and infiltrated to such an extent with the inflammatory exudation that they no longer hold the bones together; the head of the femur, if it is not already destroyed, is detached; the neck is eaten away; and the upper end of the shaft, with the great trochanter, eroded, softened, and carious, is forced by the persistent muscular contraction through the upper and back segment of the joint, ploughing its way out partly through the rim of the acetabulum, partly through the capsule, until what remains of it rests upon the dorsum of the ilium, causing *dislocation by destruction.*

It must not be forgotten that, provided the patient escapes the dangers of complications and intercurrent disorders, the process of destruction may come to an end at any time, and repair gain the upper hand. Tubercular arthritis is distinctly of limited duration: after a time it ceases to spread; the granulations become partly absorbed, partly organised; the caseous masses are encapsuled or discharged externally, often leaving sinuses behind; and anchylosis, fibrous or osseous, with more or less distortion and deformity, results.

Symptoms.—*Limping*, caused by the rigidity of the muscles and the endeavour to save the joint as far as possible, is the first symptom noticed in most instances. The hip is never quite straightened in walking; the amount of flexion allowed is limited, so that the step is short, and very often at the same time the toes are turned out more than those of the other foot. At first it is only present, or at least noticeable, when the child is tired, and it may be painless; later, it becomes continuous, and is attended with such suffering that the child can hardly rest any weight upon the affected leg.

Pain in the earlier stages is very variable. In chronic cases in particular, it is exceedingly slight, and is often regarded as merely growing-pain, coming on after any unusual exertion. In acute ones, on the other hand, and when the bone is exposed, it may be of the most intense description, the patient sitting grasping the limb with both hands to prevent the least movement, and crying out with apprehension if anyone approaches the bed. Starting-pains at night are often very severe when the cartilage is partly separated from the bone on which it rests.

The locality of the pain is very remarkable. In a large proportion of cases it is referred to the skin on the inner side of the knee-joint, sometimes to the front, and it is not an unusual thing to find that the knee has been examined time after time, painted with iodine, blistered, and even placed on a splint, while the real seat of the disease has been entirely overlooked. In other instances it is referred to the hip itself generally, or to the front of the thigh, or even to the leg; sometimes, particularly in the acetabular form, it is chiefly seated in the iliac fossa above Poupart's ligament, or over the tendon of the adductor longus. The explanation is to be found in the fact that pain, caused by irritation of a deeply seated branch of a nerve, is usually referred to one of the cutaneous divisions, just as cancer of the larynx causes pain in the ear, and a stone at the neck of the bladder gives rise to an intense cutting sensation at the end of the prepuce. The cutaneous division of the obturator is the one most often selected, because of the peculiar distribution of that nerve to the inside of the hip-joint and to the ligamentum teres; but it may be referred to the middle or internal cutaneous of the anterior crural, and even to the long saphenous and the branches of the sciatic plexus. There does not appear to be any constant relation between the seat of pain and the extent or position of the disease, though when it is severe, especially at night, it may be taken as indicating that the bone is involved.

Tenderness on pressure is usually distinct at an early period, especially in Scarpa's triangle, just below Poupart's ligament, and behind the great trochanter—in other words, where the joint is most superficial—and, in association with other symptoms, is of very great value in distinguishing hysterical affections of the hip from real. In the former, it is usually cutaneous, and often, if the attention is diverted, deep steady pressure is well borne; in the latter this is reversed, and superficial tenderness is rarely present unless the inflammation is acute or there is commencing suppuration. Sudden jarring of the heel or knee, so as to bring the two articular surfaces smartly into contact with each other, causes pain at an early period of the disease, and should always be avoided.

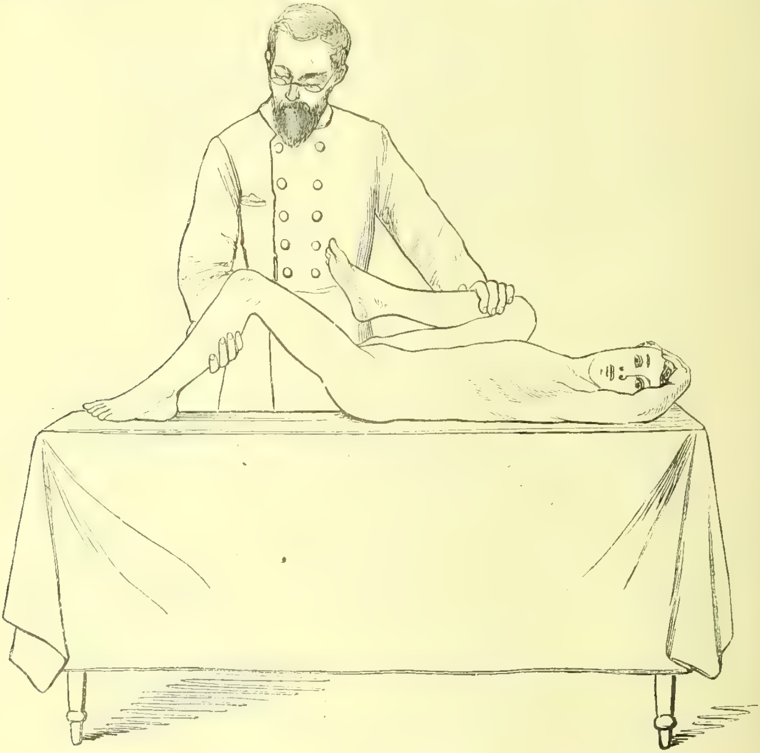


Fig. 240.

The attitude of the limb is of very great importance. Throughout the disease, from first to last, the hip, if left to itself, is always flexed. The two legs may be placed apparently in full extension side by side upon a couch with the knees perfectly straight, but this is due to the curving forwards of the lumbar vertebræ (lordosis) in compensation, and if the hand is placed beneath the loins, the alteration can be felt at once—the back does not rest upon the couch. If now, with the hand still there, the affected limb is gently raised, the vertebral column gradually becomes straight, and the hollow disappears. The number of degrees through which the limb must be moved, in order to effect this, may be taken as the measurement of the flexion of the joint.

For purposes of diagnosis, Thomas places the patient upon a table or hard couch, flexes the sound limb until the thigh touches the abdomen, and the leg the thigh; and then directs the patient to straighten out as far as possible the hip that is diseased. As the back is straight and the pelvis fixed, measurement of the angle is easy (fig. 240).

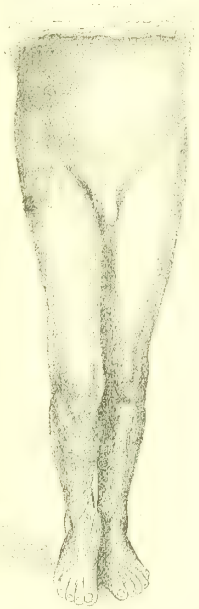


FIG. 241.—Attitude in early stage of hip-disease; the hip and knee flexed, and the heel rested.

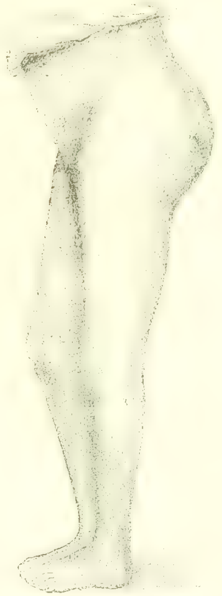


FIG. 242.—Side view of the same.

It rarely happens, however, that the flexion is perfectly straight. In the early stages there may be a considerable degree of abduction. In the later, there is always adduction, and with the former there is always apparent lengthening, with the latter, apparent shortening; that is to say, when the patient is lying down with the limbs parallel and extended (the lordosis being neglected for the time), the foot of the affected side appears either much lower or much higher than that of the sound one. That the alteration in length is apparent only at this stage, can be shown at once by examining the pelvis: the iliac spines are raised or lowered, exactly in proportion to the feet, but it is necessary to make certain of this, as, later, the shortening often becomes real.

The association of abduction with apparent lengthening, and adduction with apparent shortening, is sufficiently obvious. The angle of lateral deviation is fixed absolutely beyond the patient's control, so that the legs, when they are placed side by side, cannot be at right angles with the pelvis. If now the lower limbs are brought into the same straight line with the trunk, it follows as a natural consequence that the pelvis must be tilted. Just as in flexion there is a corresponding degree of lordosis, so in this there must be a compensatory lateral deviation of the spine. The same thing holds good, whether it is abduction or adduction, only the tilting is in the opposite direction (figs. 243 and 244).

The measure of this tilting may be taken by abducting or adducting the affected limb from the middle line, until a tape, stretched from the episternal notch to the inner malleolus of the sound leg, passes exactly over the umbilicus, showing that there is no lateral curve, and crosses at right angles another which joins together the two anterior superior spines.

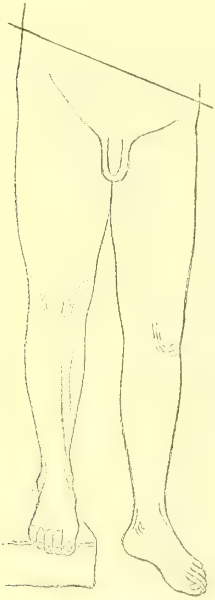


FIG. 243.—The legs parallel and the pelvis tilted, because the angle of the affected limb (whether it is abducted or adducted) is fixed, and beyond the patient's control.

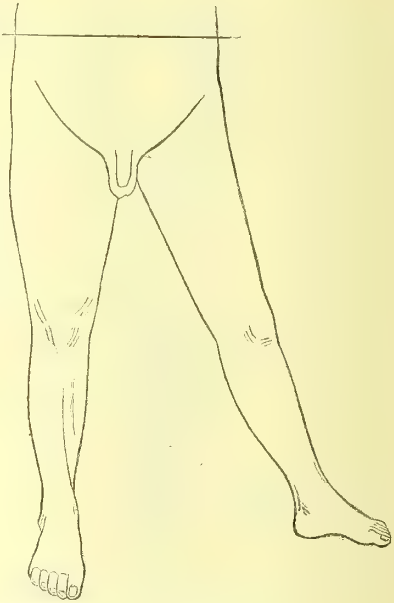


FIG. 244.—Pelvis brought to its proper position by abducting the thigh on the diseased side.

Later in the course of the disease, adduction is caused by the alteration in shape of the articular ends of the bones, and by their displacement or dislocation; and then it is always associated with real shortening. Occasionally adduction of both limbs, with extreme eversion (scissor-legged deformity) is met with, probably, as suggested by Lucas, brought on by the patient involuntarily twisting his legs into the best position for progression, under the circumstances.

Many reasons have been assigned for the change in the position of the affected limb. Flexion, as already mentioned, is present throughout. In the early period, while it is still slight, and associated with abduction and eversion, it is assumed because it is the position of greatest ease—that which causes least tension on the muscles and ligaments and least pressure upon the head of the bone; and it has been found by experiment that this is the position in which the capacity of the hip-joint for fluid is the greatest. Afterwards, however, when it is combined with adduction and inversion and is carried (as it frequently is if left to itself) to such a degree that the limb is bent to an acute angle with the trunk, this holds good no longer, and the cause then is the spasmodic contraction of the flexors. Just as in the knee-joint they gradually flex the leg upon the thigh until the calf is in contact with the ham, so here they overcome the extensors, and flex and adduct the thigh upon the trunk until, if it is not checked in some way, the limb can go no farther.

Muscular wasting affecting the extensors is one of the earliest and most valuable signs. The glutæus maximus on the affected side is flattened and feels flabby in comparison with the other; and the lower glutæal fold is partially obliterated. This atrophy is probably reflex, due it may be to some form of descending neuritis, and must be distinguished from that form, occurring later in the disease, and affecting all the muscles of the limb equally, caused by disuse.

Impaired mobility, which is always present from the very earliest days of the disease, is the most valuable symptom. At first it is due to muscular rigidity and spasm, and disappears completely under an anæsthetic; later it is caused by adhesions round or inside the joint, and at length in some cases by bony anchylosis. Perfect extension is impossible; apparently it may be carried out, but this is a deception, due to the lordosis. Perfect flexion is equally out of the question. If the finger is placed on the anterior superior spine of the ilium on the sound side, and the limb is flexed, taking care to keep it in a straight line with the body, without abducting it, the pelvis remains perfectly steady until the front of the thigh touches the abdomen; if the same is then done on the diseased side, the pelvis begins to rotate from under the finger, sooner or later, according to the degree of limitation. Rotation is equally important; if the thigh is flexed to a right angle upon the trunk, absolute freedom of movement should be allowed in either direction. It is almost certain that hip-disease is not present, if, with the patient lying on his back, with the hip and knee flexed until the foot of the affected limb rests upon the couch by the knee of the sound one, the thigh can be abducted until it rests upon its outer side. In this position there is an immense strain thrown upon the inner part of the capsule, and if there is the least degree of inflammation, the pelvis will rock from one side to the other instead.

Swelling is exceedingly significant, not so much of the existence of hip-disease, for it may be absent at the first, but of the stage which has been reached. If it occurs in the early days, filling up the hollow of Scarpa's triangle when the limb is flexed and abducted, it points to effusion in the synovial sac, such as is more usually met with in rheumatic and traumatic synovitis than in tubercular disease. Later it may be best appreciated by grasping the joint between the finger and thumb, from before backwards. Definite thickening of the base of the great trochanter is almost proof of caseation: general infiltration of the periarticular tissues rarely comes on until the disease is far advanced.

Alteration in the length of the limb.—Apparent lengthening and shortening have been already mentioned; they are due entirely to abduction or adduction. Real lengthening is very doubtful. It is just possible that it may occur from increased growth of the limb; but the circumstance must be quite exceptional, and it must not be forgotten that inequality of the two legs is by no means unusual. The head of the femur is sometimes separated from the acetabulum by fluid insinuating itself between the two cartilaginous surfaces; and possibly the same thing may be effected by the growth of granulation-tissue from one or both of the bones, but either of these conditions would prevent the limb being placed in extension, and measurement taken with the least degree of flexion is most deceptive.

Real shortening, on the other hand, at a later period of the disease, may be caused in various ways. In the most common, the head of the femur and the rim of the acetabulum, against which it is driven by the muscular contraction, mutually destroy each other. Pressure on inflamed bone very rapidly causes absorption and disintegration; the head of the femur diminishes in size at the same time that it cuts a way through the margin of the acetabulum, and the mutual destruction, even if it does not end in a kind of dislocation, causes a very considerable degree of shortening. In rarer cases the floor of the acetabulum is perforated; or the head of the bone is pushed out from the socket by the fluid that accumulates behind it, forming what is known as *dislocation by distension*; or the epiphysis is separated from the neck, and the latter is carried up against the upper and back part of the capsule of the joint. In addition, the limb is always shortened by the loss of the epiphysis and, what is much more important, by the general failure in nutrition of the part.

A sliding-rod should always be used to estimate this in preference to a tape, and the measurements should be taken from the anterior superior spine to the internal malleolus, but there are many sources of fallacy. A slight degree of flexion causes a diminution in length. Owing to the alteration in the shape and position of the articular surfaces, real shortening is always associated with adduction; as a consequence the pelvis is tilted to one side, and when the legs are brought to the same line with the body, apparent shortening is added to the real. In most cases, therefore, it is necessary to supplement this by Nélaton's line, Bryant's triangle, or by measurement of the bones of the limb separately.

Increase of temperature is very rarely present in tubercular arthritis, unless there is an acute abscess approaching the surface.

As the disease advances, other symptoms begin to appear. The deformity due to destruction of the bones and ligaments becomes more marked; flexion and adduction grow worse; the shortening of the limb is no longer apparent, but real; wasting is no longer confined to the extensors, but involves all the structures of the thigh; starting-pains make their appearance at night, and caseation soon follows.

True suppuration is a complication and may not make its appearance so long as the skin is intact. Sooner or later, however, some caseous focus in the centre of a mass of granulations slowly softens, and becomes liquid. Usually this begins in the interior of the joint, and often in the interior of the bone; but occasionally it is periarticular from the first. The orifice in the capsule, however, is generally very small and is easily overlooked. The direction the fluid takes depends on anatomical relations. It may work its way out through the posterior thin part of the capsule behind, and point under the glutæus maximus, or pass under the transverse ligament to the inner side of the limb. Sometimes it comes out through the front, along the course of the branches of the external circumflex, or, in older patients, it opens into the bursa under the psoas. A very common situation for it to show itself is just in front of the insertion of the tensor fasciæ femoris, guided, in all probability, by the firm sheet of fibrous tissue that lies beneath it; but it may run up the sheath of the psoas or work its way into the perinæum, and burst into the ischio-rectal fossa or even into the rectum. Intra-pelvic collections of this kind nearly always point to disease of the acetabulum; sometimes they originate independently on the pelvic side between the bone and the obturator fascia; in other cases they are due to perforation of the floor. Even when small their presence can usually be detected by examination with the finger in the bowel; as they enlarge they spread upwards, causing a fulness in the iliac fossa over Poupart's ligament, and pointing generally near the anterior superior spine. When the disease involves the pubes, the opening is usually either by the side of the adductor longus tendon, or in the groove between the scrotum or labium and the thigh. Old cases of hip-disease very commonly present sinuses discharging a thin purulent fluid from time to time, in several of these situations.

Constitutional symptoms.—In the early stage of hip-disease these are very slight. Caseation and liquefaction may generally be suspected if there is definite and regular rise of temperature every evening. Later, when suppuration occurs this is always present. Hectic, the various forms of fever caused by septic absorption from ill-drained suppurating cavities, amyloid disease, and other troubles which are not uncommonly met with at a later period still, must be regarded as complications which occur in tubercular arthritis in common with other varieties of joint-disease.

Diagnosis.—Advanced hip-disease is usually clear at the first glance: in the early stages the diagnosis is often a matter of the utmost difficulty. The symptoms are very slight; many of them are present in other affections, and worst of all, as it is necessary to prove that the joint is sound, they are often imitated with great exactness in hysteria. The examination must be thorough; no symptoms may be neglected; but the limitation of movement even in the slightest degree, the wasting of the extensors and the position assumed by the limb, are certainly the most important.

The diagnosis must be made from other diseases of the hip-joint; malformations; diseases of other joints; inflammation of neighbouring structures, and hysteria.

Inflammation of the hip-joint due to other causes is very rarely insidious. Traumatic synovitis may occur in children, and requires especial care, as after a temporary improvement it becomes sometimes the starting-point of tubercular disease. Syphilitic inflammation is rare, even in the hereditary form, and probably could only be diagnosed by the result of specific treatment. Rheumatic synovitis is much more acute, and chronic rheumatoid arthritis, which does, as a rare exception, affect the hip in children, may be distinguished by the character of the articular changes.

Congenital dislocation of the hip, rickets, and infantile paralysis sometimes produce a condition of things which in the absence of any history, or if the patient is hysterical, may give rise to considerable difficulty. Movement, however—especially rotation in the flexed position of the limb—is rarely restricted.

Tubercular disease of the sacro-iliac joint may present essentially the ame symptoms ; in addition, however, there is always pain in attempting to eparate or press together the iliac crests ; and usually there is a certain amount of fulness over the joint posteriorly. Lateral curvature of the spine, which may result from disease of the hip, is occasionally mistaken for, and reated as the primary affection. Mistaking disease of the hip for disease of he knee, owing to the pain in the latter, is much more common. It must not be forgotten, however, that the two may occur together.

Chronic ostitis or periostitis of the upper end of the femur is most difficult, especially as it is always associated with a certain degree of synovitis. The severity of the pain, especially at night, the great tenderness over the rochanter, and possibly the early development of œdema of the skin covering t, distinguish them, but exploratory incision is generally required. The same difficulty occurs with a rare form of central sarcoma involving the upper end of the bone.

Inflammation of the bursa under the psoas, or of the psoas itself, imitates hip-disease exceedingly well, especially in young adults. The bursa, generally speaking, develops in childhood, but does not attain a very large size for some years, and rarely communicates with the joint until late in adult life. As a rule the diagnosis can be made by the free rotation allowed when the hip-joint is flexed. More rarely the same thing occurs in connection with one of the glutæal bursæ.

Perityphlitis, iliac and psoas abscesses, and inflammation in connection with the lymphatic glands, or with the cellular tissue around the hip-joint, occasionally give rise to a certain amount of difficulty ; but this nearly always results from special attention being paid to one single symptom. If the whole case is thoroughly and carefully investigated, such a mistake can scarcely occur.

The same may be said of hysteria : the position of the limb may be exact ; the pain may be felt in the knee ; there may be limitation of movement just as there is in real disease of the joint, but it rarely happens that these symptoms are in accordance with each other. Cutaneous tenderness, for example, may be excessive without there being any pain on deep-seated pressure ; intra-articular pressure may be well borne when the hand is applied to the heel, but exceedingly painful when the knee is touched ; or there is some other gross discrepancy which effectually negatives the idea of serious disease.

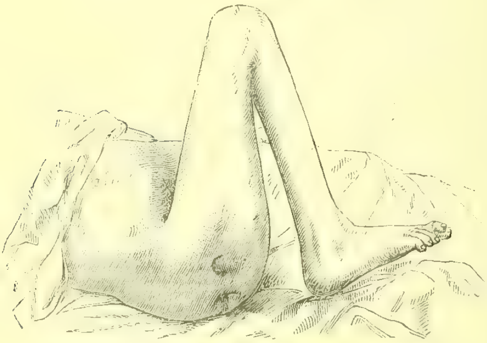


FIG. 245.—Attitude of advanced hip-disease.

The stages of hip-disease.—For convenience in description it is usual to divide hip-disease into various periods distinguished by certain clinical features, of which the position assumed by the limb is the one usually selected.

In the first, flexion is slight, and is, or is not, accompanied by slight abduction.

In the second, flexion is well marked; abduction and apparent lengthening are present as a rule: sometimes, however, there is adduction.

In the third, flexion is combined with adduction and apparent or real shortening.

As, however, this gives little or no guidance for treatment, and as it cannot be said that the position of the limb invariably corresponds with the pathological changes, a classification closely resembling that proposed by Adams is more satisfactory.

First stage: to the beginning of caseation, without thickening of the base of the trochanter or an evening rise of temperature. Perfect recovery possible, the granulation-tissue being completely absorbed or organised.

Second stage: caseation, but no general thickening around the joint or periarticular infiltration. Recovery more doubtful, with great danger of relapse, some risk of general tubercular infection, and some limitation of movement.

Third stage: the capsule softened; the limb adducted; the shortening apparent at first, but later becoming real; extra-articular suppuration; and permanent deformity, with much greater risk of tuberculosis and liability to the various forms of septic infection, hectic, and amyloid disease. If the patient escapes these dangers the tubercular process may come to an end; and gradual organisation take place, with the formation of residual abscesses from time to time.

Treatment.—The general principles are of the most simple character. Every care must be taken, by appropriate hygiene, good food, tonics, cod-liver oil, &c., to improve the general health, as already described. The first thing is to bring the limb into good position; the second to keep it absolutely at rest until it has thoroughly recovered. During the acute stage and so long as the pain is severe, the child should be confined to bed; afterwards, if it can be kept under proper supervision, it may be allowed to get about on crutches, with the limb protected against movement and accident by means of a suitable apparatus. There is no doubt that the evil effects of a prolonged confinement to bed have been much exaggerated; but, on the other hand, provided the deformity is corrected, and the limb is properly secured, no purpose is served by retaining the child there, during the long period of convalescence.

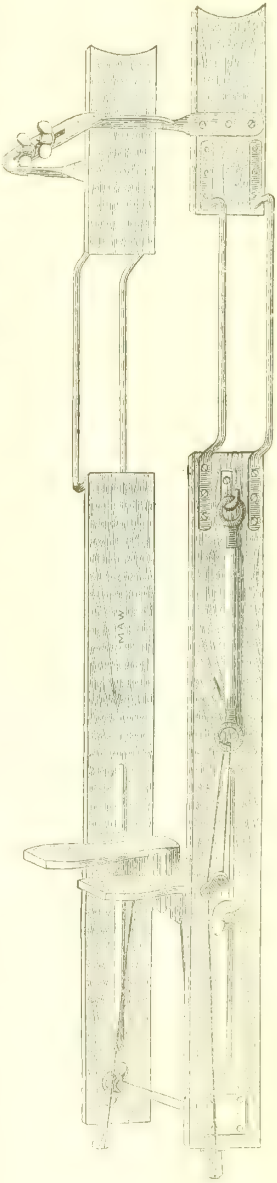


Fig. 246.—Bryant's splint for parallel extension.

(*a*) *In the first stage.*—The apparatus in general use is either a long splint with weight-extension, or Thomas' splint; but the surgeon must be prepared to make use of others, such as Bryant's (fig. 246), or to devise them for use in exceptional cases, where, for example, there is disease of both hips or some unusual deformity.

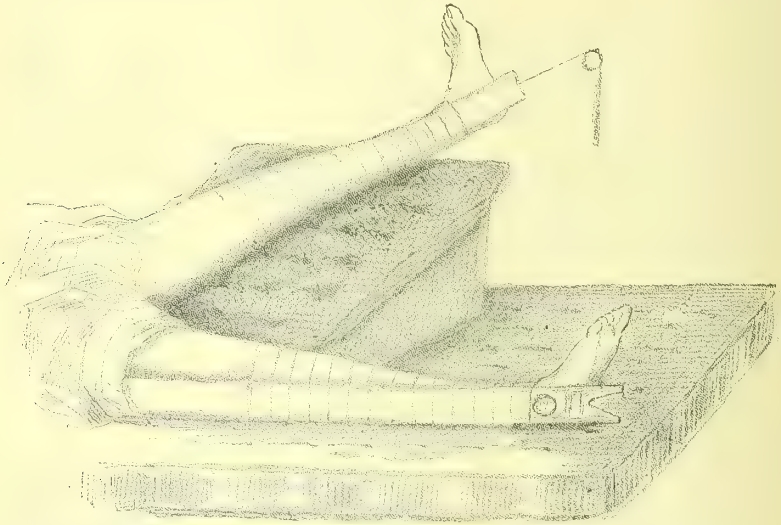


Fig. 247.—Weight-extension in the faulty position. Abduction and flexion.

Weight-extension is advisable if the symptoms are very acute; it prevents intra-articular pressure as well as friction, and secures complete muscular relaxation. It is most easily applied by means of an ordinary stirrup, fastened above, as well as below, the knee with circular pieces of strapping and a bandage. Care must be taken that there is no pressure upon the malleoli; and that the weight is not applied for some hours after the stirrup

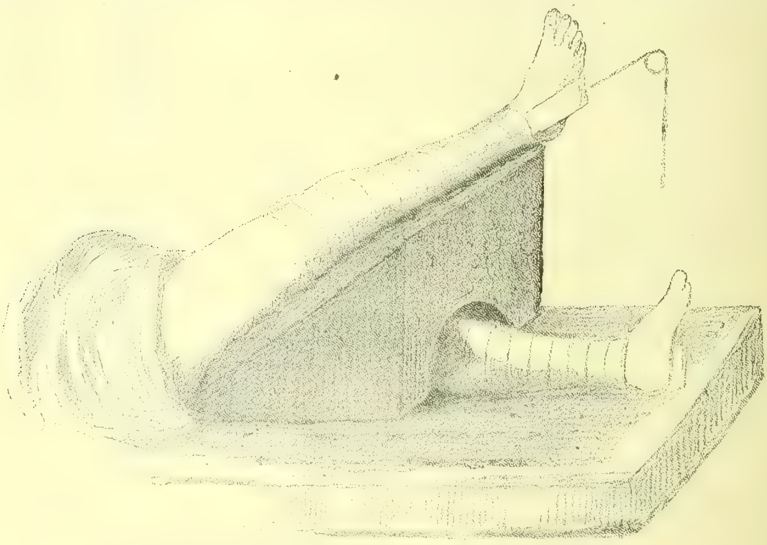


Fig. 248.—The same, but with the limb adducted and flexed.

is finished, for fear of the strapping giving way. Three or four pounds are sufficient for a child; six or eight for a young adult.

The position of the patient is secured by means of a long splint, reaching from the axilla to below the foot, applied to the sound side of the body. In the case of a child the shoulders should be fastened down by means of a chest-band and braces, so that he cannot raise himself from the recumbent position. The direction in which extension is made depends upon the attitude of the limb. If the patient is under an anæsthetic, and the hip-joint lies perfectly straight, showing that the deformity is purely muscular, extension—provided it is begun before the muscles regain their tone—may be made in the axis of the body. The steady pull upon the limb, as consciousness returns, prevents the spasmodic contraction causing any pressure upon the articular surfaces. If, on the other hand, an anæsthetic is not given, if there are fibrous adhesions present, or if the muscles have degenerated and become rigid, so that the limb cannot at once assume a straight position, extension must be made in the axis of the limb, and the angle gradually straightened every two or three days. In this way the opposing structures, whatever they may be, are slowly and quietly stretched until the desired length is obtained. Extension made in the straight line at once causes the pelvis to tilt either forwards or to one side, according to the character of the deformity, and forces the head of the bone against the acetabulum, the resisting structures in front acting as the fulcrum of a lever.

Flexion is generally easily remedied by this, so long as it is dependent upon muscular rigidity or extra-articular fibrous adhesions. Eversion or inversion of the foot can be cured at the same time, either by placing the side portions of the stirrup rather obliquely upon the limb, or by adjusting to its outer side a short splint with a cross-piece at the bottom, which can be raised at one end and lowered at the other until the required correction is made. A moderate degree of abduction is not objectionable: indeed, it is to some extent beneficial, and should, for example, be maintained after excision, as, by causing apparent lengthening, it tends to correct any real shortening; but, for the same reason, adduction is especially to be avoided. Marsh recommends that, where its extent is at all serious, counter-extension should be made from the splint on the sound side of the limb in the opposite direction—that is, towards the head of the bed—so that the pelvis may be slowly twisted round. Thomas' splint, however, is more likely to succeed.

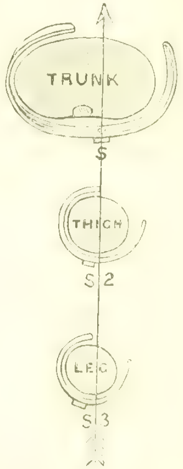


FIG. 249. — Diagrammatic sections of trunk and lower extremity, showing application of hip-splint and hoops.

With regard to the length of time this treatment should be maintained, no general rule can be laid down. The faulty position of the limb must be corrected, the muscular rigidity must disappear, and when the weight is reduced by slow degrees, there must be no tendency to return of the flexion. It may be many months before this takes place, and even then the limb must be protected by means of a Thomas' splint; the patient must be contented to get about on crutches with a patten under the opposite foot; the weight should be reapplied at night, and careful watch must be kept for any return of the pain or muscular rigidity.

Thomas' splint, on the other hand, aims at securing muscular relaxation, not by extension, but simply by rendering the joint absolutely rigid. The muscles are in a state of spasm, because the least movement causes pain; if the joint is fixed so that motion is impossible, they relax of themselves and allow the limb to become straight. The only extending force is the weight of the part, and this, even when there are fibrous adhesions round the joint is generally sufficient to correct the deformity without having recourse to other measures. In the hands of the inventor (who uses it for all stages of the disease) it has proved most successful, but it is by no means easy to apply properly and effectually; the surgeon must be able to manipulate it himself, and adapt it constantly to the varying circumstances of each patient; and this cannot be done without considerable experience.

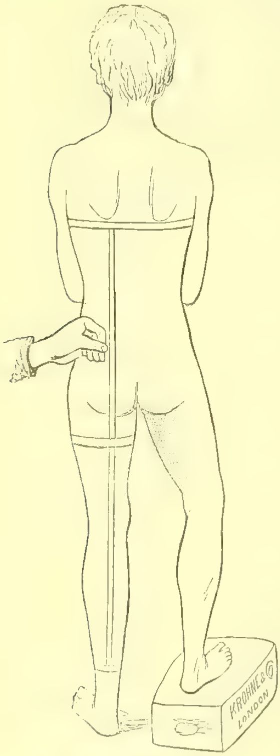


FIG. 250.—Measuring for Thomas' splint.

It consists of a flattened bar of malleable iron, sufficiently strong to bear the weight of the patient without bending, and long enough to reach from the angle of the scapula to below the calf. This is bent so as to fit in the lumbar region, just external to the posterior superior spine, curve forward under the glutæal fold, and run down the leg slightly to the inner side of its middle line. In addition, it is slightly twisted on its long axis in the glutæal region, so that while the lumbar portion looks forwards and inwards, the lower half is directed slightly outwards; the extent of this twist varies with the build of the patient, and must be increased if the splint has any tendency to shift away from the spine. On this are riveted three metal hoops, one round the chest, the second round the thigh just below the glutæal fold, and the third round the calf; the first equal to five-sixths of the circumference, the other two about two-thirds, at their respective sites. These are not fastened in the centre, but rather to one side, so that one arm is longer than the other: that is to say, if the right hip is affected, the left arms of the three hoops are the longer, reaching to almost the middle line, and cling closely to the skin; the right ones are shorter, and are somewhat set away. The upper crescent is closed round the chest by means of a strap and buckle and the splint is fixed to the chest and to the limb by means of two flannel bandages.

The age and sex of the patient, the side that is affected, and any peculiarities as regards position, must be noted. The chief measurements are the circumference of the body at the nipple line; of the thigh, two inches below the glutæal fold; and of the leg below the calf; and the length from the nipple-line to the same two places.

In every case the splint should be modelled to the sound side of the body, no matter how great may be the degree of flexion. Padding should be used freely to fill up the hollow under the loins and in the bend of the knee, so that the patient may rest comfortably upon the bar; gradually, as the cotton-wool gives way and becomes compressed, the body and limb sink with it, and straighten themselves out. Of course, if the deformity is considerable, the hoop that goes round the thigh cannot be closed at first, and its sides may even require to be prolonged; and care must be taken to prevent the back of the heel resting upon the lowermost hoop. Slight alterations of this kind can be easily effected by wrenches, but it is seldom practicable to bend the main support of the splint so as to fit the limb without injuring it more or less, and it is not necessary; the splint answers quite as well if it is modelled to the sound side of the body from the first.

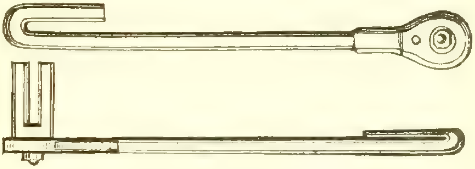


Fig. 251.—Thomas' wrenches for altering splint.

Special attention must be paid to the method of application of the splint and bandages. The long arm of the upper hoop is bent to fit closely to the body; the short one is opened sufficiently to place it in position; and the strap of the body-band is fastened round the chest, care being taken that the buttock rests well in the hollow. Two bandages are required: one broad, for the body; the other narrow, for the leg. In each case they must be fastened to the splint first. The former is to draw the vertical bar well towards the spine; the operator stands upon the sound side, passes the end of the bandage first under the splint, then between the body and the splint (leaving an end sufficiently long to be firm), and then round body and splint from below upwards. The direction of the other depends upon the inversion or eversion of the limb, the turns being made to correct the deformity as far as possible. While it is being applied, the foot should be held slightly inverted, in the natural position. The whole splint is prevented from slipping down by means of a brace over the shoulder; if there is abduction,

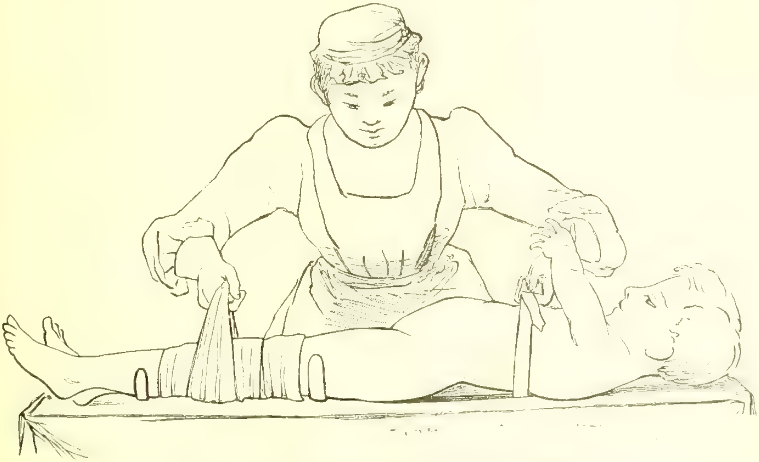


Fig. 252.—Showing method of lifting patient.

it is placed on the affected side, if adduction on the sound one. So long as the symptoms are acute the patient is confined to bed, and he should not be allowed to get about until the leg and back are perfectly straight.

Whenever the deformity is at all serious a double splint should be used, the two vertical bars being connected together so as to ensure complete rigidity.

Abduction is checked by lowering the longer limb of the upper crescent until it sweeps down upon the lower ribs, or even between the ribs and the iliac crest; adduction by adding a pelvic hoop on the affected side just below the iliac crest, joining it to the upper one by a lateral bar, and then bandaging the body to both the vertical supports. If there is any knock-knee the outer limbs of the two lower hoops may be connected in the same way. Inversion and eversion can be greatly improved by bandaging, or, so long as the patient is in bed, by fastening a transverse bar to the lower end of the splint so as to tilt the limb in either direction as required. The ironwork is either covered over with leather, or with metal foil if there is any difficulty in keeping it clear.

The splint must be worn day and night until the muscles round the joint show evident signs of wasting, and the limb is painless and straight. Then it may be laid aside at night; and after a time, if no rigidity or flexion makes its appearance, it may be abandoned altogether, the child simply getting about with a patten and crutches; but the majority require it for one or two years at least, and, if the disease was at all advanced before applying for treatment, sometimes for very much longer.

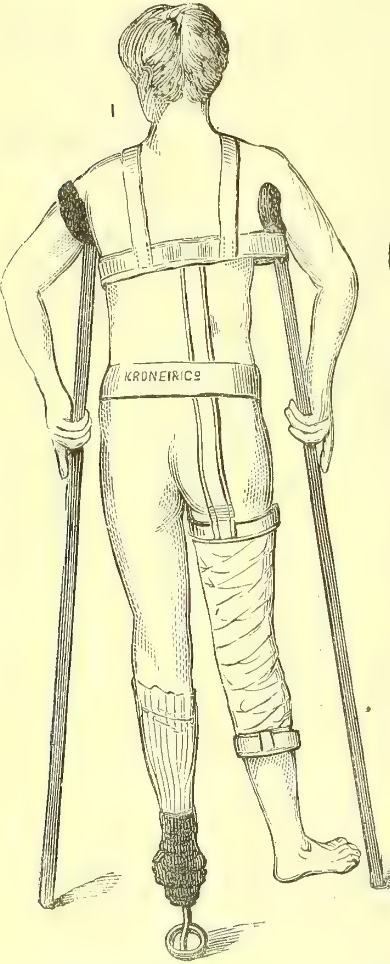


Fig. 253.—Thomas' hip-splint, arranged for walking, with crutches and patten under foot on sound side.

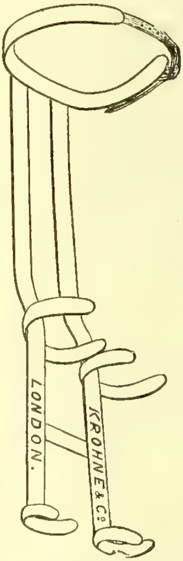


Fig. 254.—Double Thomas' splint.

(*b*) *Second stage.*—If, when the case is first seen, there is distinct thickening round the base of the great trochanter, with a regular rise of temperature of an evening, or if prolonged rest has been tried without success or with only a slight degree of improvement, and that of a temporary character, it becomes a question whether it would not be advisable to remove the whole tubercular focus, or in other words perform excision, instead of waiting for the time when the disease will cease to extend. A further trial should certainly be made if the circumstances under which the patient is placed are favourable, if, for example, two or three years can be given up, in the hope that as the patient grows older the tendency will cease and organisation take place; but, if this is not possible, the more active treatment is the better. In any case the limb will be more or less crippled and anchylosed, and it is better to remove the whole source of disease at once (provided primary union is ensured), even if a little more than is absolutely necessary is taken away, than to leave it to certain suppuration and destructive arthritis, in the hope that the pus, after it has burrowed outside the joint and undermined the surrounding tissues for two or three years, will carry away all the tuberculous material and gradually dry up.

Acute abscesses occurring in connection with hip-disease should be opened and drained as in other parts of the body. Cold ones, caused by the softening and liquefaction of caseous deposits, occasionally, under the influence of rest and food, diminish in size, gradually dry up and disappear; but even when this does happen, healing is frequently imperfect, and later, if from any cause the health fails, the abscess is very likely to fill again. Aspiration and the injection of iodoform emulsion may be tried if they are small, although with some risk of iodoform-poisoning; but the rule should be to open them freely, wash out their contents thoroughly, drain them, and if possible remove the source from which they spring. Counter-irritation, painting with iodine for example, may be of some little use in the early days of the disease, and may relieve pain and tension in the deeper parts, but it can have no influence on caseation, unless perhaps it hastens its liquefaction. Many of these abscesses are peculiarly tortuous, making their way under the muscles and sheets of fascia; and not unfrequently they communicate by narrow channels with very much larger collections, which, owing to their depth, are not apparent, so that great care is required to prevent the openings becoming valvular. In any case, as they are dependent upon diseased bone (except in the rare instances in which they are peri-articular from the first), they are sure to contract into sinuses which, until the cause comes away of itself—or, better, is removed—will continue to discharge a certain amount of serum mixed with flakes of caseous débris.

Later in the course of the disease, years perhaps after recovery, residual abscesses are not uncommon. Apparently the cicatricial tissue around the joint is very lowly nourished and is liable to break down if it is injured in any way, or even from over-exertion. In some instances these abscesses are acute and of very large size; but, as a rule, if they are opened at once, they heal up within a very short time.

(*c*) In the final stage, when the limb is shortened and wasted, more or less anchylosed, and there are open sinuses here and there round the joint, leading down to bare and carious bone, an attempt must be made to improve the position by extension (tenotomy may be occasionally required, but forcibly breaking down adhesions should be avoided as far as possible), and to reduce the amount of discharge by scraping out the sinuses and removing the softened necrosed portions of bone. In many of these cases the true tubercular process has either come to an end altogether or is merely local, causing the discharge of a little caseous pus now and then from some cavity in the bone; and the inflammation is simply kept up by septic conditions or by sequestra which are not yet separated.

The object is to save the patient from the dangers of hectic and amyloid degeneration. Sometimes, when the head of the femur is lying detached and loose in the cavity of an abscess, or the upper end of the bone is softened and carious, or portions of the acetabulum have undergone necrosis, a more formal operation is necessary, and a kind of excision (differing entirely from that which is done in the earlier days of the disease) may be performed, the sinuses being laid open and the whole of the diseased bone being as far as possible removed. The same thing may be required in the case of intrapelvic suppuration, to provide free exit through the acetabulum and prevent the pus extending indefinitely among the tissues and perhaps discharging itself eventually into the rectum or the ischio-rectal fossa.

Finally, amputation may be advisable, either because excision has been performed and the limb is useless, or to save the patient from sinking from hectic or amyloid disease. If the pelvis is involved to any extent the prospect is very unfavourable; but even then sometimes the health improves: the discharge diminishes in amount and escapes more freely, loose fragments of bone come away from time to time, very often with the formation of residual abscesses, and at length only one or two sinuses are left, discharging a small quantity of lymph mixed with flakes of caseous débris.

A slight degree of amyloid disease does not preclude either excision or amputation; in many cases it has been noticed that as the wound diminished in size and the discharge grew less, the waxy colour gradually disappeared, the liver became small again, and albumin ceased to appear in the urine.

Osseous anchylosis in a faulty position may be treated either by division of the neck of the femur, or, as the condition of the upper end of the bone is more than doubtful, and it is not impossible that the hyperæmia following the operation might cause all the mischief to return, preferably by section through the bone, in the neighbourhood of the lesser trochanter. It may be accomplished either with a chisel or with a saw. Sayre recommends the excision of a portion of the bone so as to secure the formation of a false joint; but unless so much is removed as to make union altogether doubtful, it is almost sure to be osseous.

Sacro-iliac Disease

Tubercular disease of the sacro-iliac joint is very rare in childhood, but is not uncommon in young adult life. Nearly always it can be traced back to some injury; there is an extravasation of blood, generally in the cancellous tissue of the bones, but perhaps sometimes between the cartilaginous surfaces, which, though they lie in contact with each other, are not fused together; the vitality of the tissues is lowered, the tubercle-bacilli gain access to the part, and the characteristic granulation-tissue begins to develop.

The subsequent changes are identical with those that occur in other articulations: the cartilage and the bony trabeculæ are absorbed; the neighbouring ligaments are softened, so that the joint loses its sense of stability; the amount of granulation-tissue increases until its nutrition begins to fail, and then caseation and liquefaction follow, forming cold abscesses filled with a mixture of caseous débris, leucocytes, serum and shreds of connective tissue. Sometimes these make their way out directly backwards, and point over the joint itself; occasionally they spread upwards to the lumbar region; more frequently they extend forwards, and either follow the psoas or pass out of the pelvis through the sacrosciatic foramen, or into the ischiorectal fossa, or even into the rectum. If left to themselves they break, there is a profuse discharge for a time, and then, sooner or later, unless steps are taken to prevent it, pyogenic organisms as well find their way in.

Symptoms.—At its commencement, disease of the sacro-iliac joint is even more insidious than that of the hip. There is a sense of fatigue or of fugitive pain of an evening or after exertion. The limb feels weak, standing on that leg is avoided, the weight, even in sitting, is thrown as much as possible on the opposite side of the body, the patient begins to limp, the gait becomes altered, the step in walking is shortened, and the least extra strain, such as lifting a heavy weight, even coughing, sneezing, or straining at stool, is checked at once by the pain. The locality in which this is felt is very variable: most frequently it follows the course of the obturator nerve, and is referred to the hip or knee, but it may follow that of the sciatic, or be referred to the back, or the glutæal region, or even to the anus. In many cases it is very severe, especially when any weight or pressure is allowed to fall upon the joint.

The limb is flexed at the hip and abducted: apparent lengthening is usually present. There is tenderness on pressure over the posterior surface of the joint; frequently the temperature is slightly raised, and the skin appears puffy. The glutæi waste to a certain extent from disuse, and make this more prominent. Pressure upon the iliac spines is often exceedingly painful.

Abscesses that advance posteriorly can naturally be detected at once; those on the anterior surface of the joint may sometimes be felt through the rectum, or in young and thin adults a certain amount of deep resistance can be made out by pressure on the abdomen, but as a rule they are not detected until they are beginning to approach the surface.

Diagnosis.—Inflammation of the sacro-iliac synchondrosis may occur in gonorrhœal rheumatism, pyæmia, and in arthritis deformans; the two former however, are never insidious or chronic in their course, but commence rapidly with acute symptoms, while the latter only occurs at a much more advanced period of life, and has no tendency to run on to caseation or suppuration.

In its early stage it is very liable to be mistaken for tubercular arthritis of the hip, especially that variety which commences in the acetabulum. The position of the limb may be the same; the pain may be felt at the hip or knee; limping and apparent lengthening are present in both, and unless great care is taken movements at the hip-joint are restricted and painful, because they are communicated to a slight extent to the sacro-iliac one above. Tenderness on pressure and puffiness over the sacro-iliac articulation are, however, never present in hip-disease; nor does pressure upon the iliac spines, squeezing them together or apart, ever cause pain. It must not be forgotten that the two may occur in the same subject, either independently or from the disease having extended along the psoas from one to the other.

Necrosis of the pelvis or sacrum may occur and give rise to symptoms somewhat similar; sciatica may be mistaken for it, though the converse is much more likely to happen; spinal disease may give rise to a certain amount of difficulty; and occasionally symptoms closely resembling it are present in hysteria.

Prognosis.—The prognosis is always unfavourable, but so long as caseation does not occur it is by no means hopeless. A large amount of bone may be removed by fungating caries and cicatrisation follow, leaving even a certain degree of deformity, without of necessity suppuration ever taking place. If, however, caseation and liquefaction do make their appearance, the prospect of recovery is much more doubtful. It means that the balance of power lies on the side of the bacilli; that the resistance the tissues can offer to their encroachment is very feeble; and that in all probability the progress of the case will be simply from bad to worse, until at length hectic and exhaustion set in. In only one case (Hilton's) is recovery known to have taken place without operation after suppuration had occurred.

Treatment.—Absolute and prolonged rest is even more essential in this than in disease of the hip. The loins, the pelvis, and the lower limbs must be rendered perfectly immovable by means of a large well-padded girdle of leather or plaster, carried down as low as the knee, and the patient must be strictly confined to the recumbent position without being allowed to move on any consideration. For the disease itself in this stage very little can be done; tonics, good food, cod-liver, oil and everything that can improve the nutrition of the tissues, must be given freely; and, if possible, the patient should have sea air. The only local application of any service is the actual cautery, which does diminish to some extent the deep-seated hyperæmia and tension.

If caseation and liquefaction set in and the patient is otherwise healthy, the cavity should be thoroughly cleared out, washed with iodoform emulsion and drained, so that no fluid may remain behind to decompose. If the bones are involved the carious portion must be freely gouged out and treated in the same way. This, however, had better not be attempted if there is any evidence of phthisis, or of tubercular mischief elsewhere. Recovery, with cicatrisation of the cavity left, is still possible after suppuration, so long as the affection remains local, although the probability is very much less.

Tubercular Disease of the Knee-Joint

Tubercular inflammation of the knee may commence either in the synovial membrane or the bone. In the former case (fig. 256) the whole of the synovial lining and the loose soft tissue around are converted into a mass of gelatinous granulations, in which typical miliary tubercles may be found here and there, and sometimes tubercle-bacilli. It may be an inch and a half in thickness; the cavity may be almost obliterated; the cartilages eaten away around their margin; the ligaments softened, the fibres of the capsule separated from each other, and the vascular periarticular tissues everywhere infiltrated to such an extent that the outline of the joint is perfectly uniform and the skin tense and white (*tumor albus*).

In the latter, when the tubercular deposit occurs primarily in the bone (fig. 255), the changes are to some extent the same, but they differ materially in detail. As in the hip, the neighbourhood of the epiphysis (particularly the articular surface of the shaft) is the part attacked; sometimes it is the femur, sometimes the tibia (fig. 236). A wedge-shaped sequestrum is occasionally present; in other instances there is merely a mass of grey granulations in the cancellous tissue, slowly enlarging at the periphery and caseating in the centre. Whichever it is, the periosteal surface is quickly covered with a layer of new bone, so that escape is barred in that direction. If the inflammation is acute, and the epiphysis is involved—if, that is to say, tubercular embolism on a large scale has taken place—the articular cartilage perishes with the bone on which it rests, and the interior of the joint is gained at once; when, on the other hand, the attack is more chronic, the granulations slowly approach the articular lamella; the joint becomes more or less filled with fluid; and the cartilage is absorbed from beneath or detached in flakes and thrown off into the interior. In many instances the tubercular infiltration spreads from the epiphysial line directly to the capsule of the joint.

Resolution and cicatrisation occur in this as in other forms of tubercular inflammation, and, except in the very worst cases, some trace of repair is always to be found. Caseation may begin in the thickness of the synovial membrane, or in the substance of the bone; but in many instances, even when there is very considerable deformity, it never appears at all; or, if it does, the products are absorbed and removed without leaving any evidence of their presence. The granulation-tissue filling up the cancellous spaces of the bone, replacing the cartilages and occupying the synovial cavity and the interstices around it, gradually becomes organised; the joint-cavity is obliterated; and the ends of the bones are tied rigidly together.

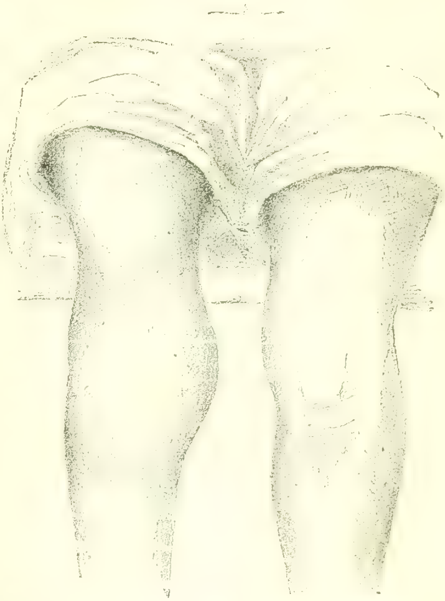


Fig. 255.—Chronic ostitis of inner tuberosity of tibia with consecutive arthritis.

On the other hand, the caseous foci may enlarge, become more and more liquid, and ultimately form cold abscesses which spread slowly in the direction of least resistance, preceded always by the tubercular deposit. Even then, if they lie in the thickness of synovial membrane or in the substance of the bone, and burst externally, repair may take place, with a certain amount of stiffness. The whole of the infecting material is discharged, or, if any is left, the tissues are able to deal with it, and organisation gains the upper hand. But where, as in some instances, caseation is almost general, so that the ends of the bones are completely bared, and the whole of the cartilage detached; or where true suppuration sets in and involves the joint-cavity, the destruction is so great that only bony anchylosis is possible.

Symptoms.—Tubercular inflammation of the knee-joint is essentially a disease of childhood or of young adult life. The synovial form is almost as frequent as the osteal; but, in the early stages at least, one can usually be distinguished from the other.

Pain, heat, swelling, and impairment of function are never wanting, although they vary considerably in different cases. There is no redness of skin until suppuration sets in and approaches the surface. On the contrary, owing to the way in which it is stretched by the chronic effusion beneath, it is often so peculiarly white that this form of inflammation used to be distinguished from all others by the name of white swelling or *tumor albus*. Later, characteristic displacement makes its appearance; the joint becomes stiffened and rigid; abscesses form; grating and starting-pains follow; and in short all the symptoms of destructive arthritis are developed.

The *aspect* differs according to the seat of the disease. Where all the soft tissue around and between the ends of the bones is equally infiltrated, the outline is perfectly uniform; no depressions or elevations are to be seen anywhere. The hollows on either side of the ligamentum patellæ are filled up the first; and by degrees all the rest share the same fate, until the skin is stretched evenly over the whole. When, on the other hand, the bone is attacked the first, or even chiefly, the swelling is limited, or at least is most marked on one side; it extends much farther up and down the bone, owing to the thickening of the periosteum, and is not restricted by the limits of the synovial membrane. There may be some fluid in the joint, or some thickening of the synovial and perisynovial tissues, but it is not sufficient to obscure the enlargement of the bone and make the swelling uniform.

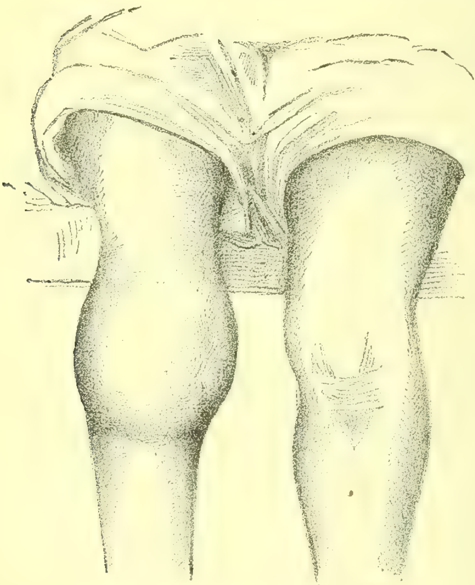


FIG. 256.—Primary tubercular synovitis.

The degree and the locality of the pain, as might be expected, show a certain difference. In primary tubercular synovitis the disease is often far advanced before the child complains at all, and even then it is only an ill-defined aching, worse after exertion; in the osteal form, on the other hand, it is one of the earliest symptoms, and is especially severe at night.

The same may be said with regard to *local tenderness*. In primary synovitis the joint (so long as it is not extended or flexed too far) may be handled freely. When the tubercular centre is in the bone the swelling is usually exceedingly tender, sometimes all over, but in many cases, especially at one small spot, the skin over which is puffy and œdematous. In the same way starting-pains at night commence at an earlier period in the osteal form and are more severe.

The other symptoms are common to the two and are equally marked in both.

Movement is always limited. Complete extension of a knee-joint that is in the least degree inflamed is impossible; and conversely a knee that can be extended thoroughly is not inflamed. This does not depend upon the amount of fluid present, although it is true that the capacity of the synovial cavity is greatest when the joint is flexed about 15°, but on the fact that in extension all the fibrous structures around and in the joint, except those on the anterior surface, are put upon the stretch. Complete flexion is equally limited, but this is more difficult to prove.

The temperature of the joint is always raised. Great care is required in establishing this: the knees must have been exposed an equal length of time; the suspected one must not have been manipulated; and the same points on each must be compared; but, if this is done, the result may be absolutely relied upon.

Muscular wasting, especially of the quadriceps, makes its appearance at a very early period; it may be distinctly marked by the end of two or three weeks.

Displacement of the tibia again occurs unusually soon. The joint is kept in the flexed position, so as to relax the muscles and ligaments as far as possible: the two bones simply rest upon each other; the ligaments are softened by the inflammation, and in the position of semi-flexion are nearly all relaxed; the hamstrings are in a state of spasmodic contraction, and from their position act with peculiar advantage; the weight of the limb, and, if the patient is in bed, the pressure of the clothes upon the inner side of the foot, help; and as a result the tibia is displaced bodily backwards upon the femur, and is at the same time rotated outwards. In the treatment of chronic disease of the knee, the prevention of this displacement is of special importance; if it is allowed to take place, and the ligaments become firm again, as they do as soon as the inflammation has subsided, it is almost impossible to bring the tibia forwards upon the femur. The flexion may be cured, and the two made parallel; but the femur is and remains in front of the tibia, so that merely the posterior margin of the condyles rests upon the upper surface of the tuberosities.

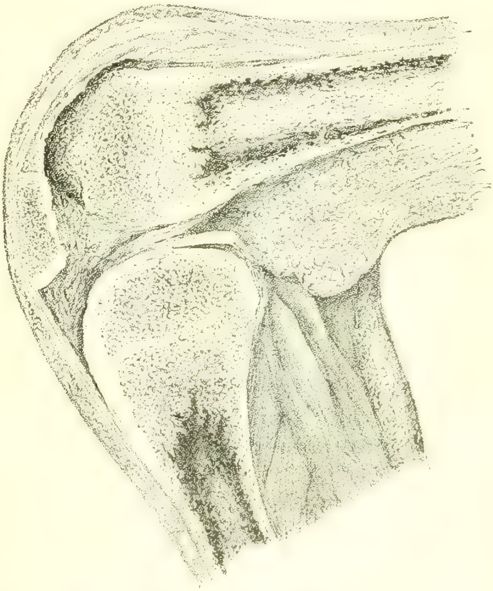


Fig. 257.—Section through a knee-joint, from a case of advanced tubercular disease. The bones are atrophied, the cartilages gone both from femur and patella, and the tibia hopelessly displaced backwards.

As the inflammation advances these symptoms steadily become worse. The joint, if left to itself, is flexed until the calf is in contact with the ham and the tibia is almost pulled off the femur; the pain grows more severe;

the swelling increases in size; abscesses make their appearance and burst externally, leaving sinuses lined with pale, flabby granulations; starting-pains come on, showing that the articular cartilages are in part destroyed; the least attempt at movement, even touching the bed, causes intense suffering; and, finally, suppurative arthritis is added to the rest.

The constitutional symptoms at first are but slightly marked; as the disease advances a certain amount of fever makes its appearance, especially of an evening; the health begins to fail, partly from this, partly from the pain and the want of exercise; and the patient loses flesh and strength. Later, when suppuration occurs, this is much more marked; the temperature becomes characteristic of hectic; the emaciation is extreme; the appetite is completely lost; the face is flushed; there are profuse night-sweats, and in some cases the strength fails to such an extent that it is difficult to believe that the disease of the knee, bad though it may be, is the only trouble from which the patient is suffering.

Diagnosis.—The age of the patient; the peculiarly insidious character of the disease: the difficulty of assigning even an approximate date for its commencement; and the soft, doughy, semi-elastic feeling, are distinctive. In primary tubercular synovitis the outline of the joint alone is sufficient; no other affection causes such a perfectly even, rounded swelling. When the disease begins in the bone the difficulty may be somewhat greater, but chronic ostitis of the articular ends of the bones very rarely occurs in children or young adults, except from tubercle or syphilis.

The history of the case is often exceedingly misleading, the lameness comes on so gradually, that very often it is never noticed by the parents until the disease is far advanced, and they may persist that the child has been perfectly well until a day or two before. Such evidence, however, is worthless in comparison with that afforded by the change in the physical characters of the joint and the wasting of the limb.

The difficulty is greatest in the case of syphilitic synovitis. This is more common in the hereditary than in the acquired variety, and is usually secondary to ostitis or periostitis of the articular ends; when, however, the synovial membrane is involved by itself, it resembles tubercular inflammation very closely. As a rule, the course is more rapid and the consistence of the swelling is seldom so uniform: but in any case of doubt, or where there is a history of recent syphilis, it is advisable, in addition to local measures, to try the effect of mercury and iodide of potash in small doses. Occasionally the difficulty is increased by the fact that tubercular arthritis makes its appearance suddenly, or perhaps is roused into greater activity by the cachexia attendant on secondary syphilis.

Other forms of synovitis can be distinguished almost at once by the rapidity of their onset (tubercular arthritis is always an affair of months, often of years), by the fluid character of the effusion, or by the tendency to organisation of the inflammatory products, leading to the formation of synovial fringes, or the production of fibrous adhesions. It is not improbable, however, that senile tuberculosis and Charcot's disease are occasionally confused with each other at the beginning.

Hysteria may attack the knee-joint almost as frequently as the hip, and by prolonged disuse may lead to a great amount of wasting and some rigidity. It can, however, be nearly always distinguished by the incongruity of the symptoms it presents.

Prognosis.—In spite of the size of the articulation, the prognosis in tubercular inflammation of the knee is distinctly more favourable than in that of the hip: the joint is more superficial; the bones can be fixed more easily; and if a caseous focus makes its appearance in either the femur or the tibia, it can be scooped out from the side without interfering with the synovial cavity. Everything, however, depends upon the period at which the diagnosis is made, and the thoroughness with which the treatment is carried out. Recovery may be perfect; or fibrous anchylosis, allowing more or less movement, may be left; or the bones may be fused together; or, finally, excision or amputation may be required.

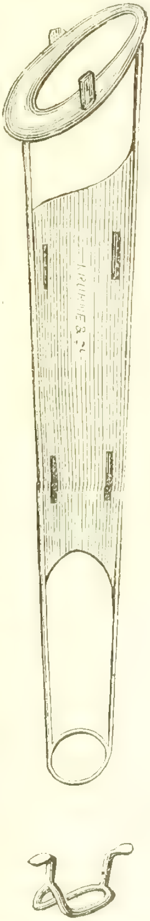


Fig. 258.—Thomas' knee-splint, with patten.

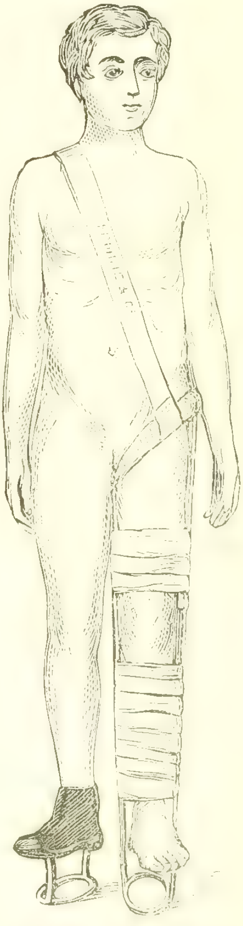


Fig. 259.—Thomas' knee-splint, applied.

Treatment.—The principles are the same as those already detailed. The greatest attention must be paid to the general health; the limb must be brought into good position and kept absolutely at rest; if caseation sets in and the inflammation does not subside, the focus of disease, whether it is in the synovial membrane or the bone, must be thoroughly cleared away; if this cannot be done without removing the articular ends, or if anchylosis has taken place in such a position that the limb is useless, excision must be performed; and if the patient is in danger of sinking from hectic, or if the constitutional condition is such that a possibly protracted convalescence could not be borne, the thigh must be amputated.

The position for the knee is almost straight; if it has already become bent, it must be slowly and quietly brought nearly into line again, either by means of weight-extension or with Thomas' splint. If the former is used, the same precaution must be taken as in the case of the hip-joint, to make the extension in a line with the leg and not with the body, so as to avoid causing intra-articular pressure. This may be accomplished by placing the leg upon a well-padded horizontal rest at a suitable height above the bed, and adjusting a weight by means of a stirrup.

Thomas' knee-splint is no less valuable than that devised for the hip. It consists of an upper ring fitting accurately round the thigh as high up as possible, and of a strength proportionate to the weight of the patient; and of two upright iron rods, coming down one on each side of the leg and terminating below in a patten. These should be so long that no part of the foot can in any way touch the ground when the splint is adjusted. The upper ring, which is thickly padded on its inner side and behind where the tuberosity of the ischium rests upon it, is placed at an angle of 45° with the inner of the two uprights. In front, where it lies just below Poupart's ligament, it is nearly straight, to correspond with the flattened surface of the front of the thigh; behind it is fuller; and at the outer end, which lies under the anterior superior spine, it is more sharply bent than at the inner. The outer upright is attached exactly at the mid-lateral line; the inner one should be a little in front of it. This ring is supported in position by a broad strap passing from front to back over the sound shoulder.

Between the two uprights there is a broad apron of leather extending from above the middle of the thigh to below that of the leg, so that the limb rests on it, between the bars. Near its upper end there are two slits, one on each side, for the bandages that are used to fix the thigh. This part of the limb must be as firm as possible. Two bandages are employed, one for each bar; and each passes round the limb and one bar first, and then outside everything, round splint and limb. The object is to fix it so that, when the patient is lying down, the patten below the foot can be raised or lowered, moving from the hip-joint, without the knee experiencing the least sensation. The leg, which need not be fastened so firmly, is secured by a stirrup attached to a bar at the bottom of the splint (but not with the view of causing extension) as well as with side bandages. If the knee is much bent, the apron cannot be used; the patient must be kept in bed with the patten supported and raised, so that the weight of the limb gradually straightens out the joint. Afterwards, when the position is better and the acute symptoms have subsided, a patten is placed under the opposite foot to equalise the two limbs, and the patient is allowed up, on crutches, resting a little of his weight on the tuberosity of the ischium.

In the case of younger children, or where the pressure of the ring on the inner side of the thigh causes inconvenience, the limb must be secured by leather splints or by plaster-of-Paris, gum and chalk, or some other of the appliances described under the head of fractures, but they do not secure such absolute rigidity.

In the vast majority of cases, if the child can only be tided over a period of one or two years, a fairly good result may be obtained by this. Splints may have to be worn for a very long time; the range of movement may be limited, and the muscles may waste considerably, but the growth of the part is not affected, and by degrees the risk of general tuberculosis and of relapses becomes less and less.

In the synovial form elastic compression, by means of many layers of absorbent wool, may be tried with advantage; it helps to reduce the hyperæmia, promotes absorption, and keeps the part in the most perfect rest. When the disease commences in the bones, especially when there is a tendency to starting-pains at night, progress may be checked, for a time at least, by means of the actual cautery, applied at a black heat, while the patient is under an anæsthetic.

If caseation and liquefaction occur in the synovial membrane, the cavity should be tapped and injected with iodoform emulsion, in the hope that, if this mass of caseous material is dealt with thoroughly, the disease will cease to spread, and that under proper treatment organisation and cicatrisation will gain the upper hand, until the age is reached when the tendency is for the tubercular process to come to an end. In the osteal form, when a tender and swollen spot can be definitely distinguished on one side of the joint, unless the symptoms speedily and thoroughly disappear, there should be no hesitation in making an exploratory incision; and if the periosteum is thickened or separated from the compact layer of the shaft by inflammatory effusion or a deposit of new bone, it should be carried into the substance of the bone beneath. It is no uncommon thing, when performing excision for old disease of the knee-joint, anchylosed in a faulty position, to find a cavity sometimes containing a sequestrum, in one or other of the bones, communicating with the interior by means of a long narrow sinus.

If the thickening of the synovial membrane continues to increase in spite of treatment, arthrectomy may be performed, but it is an operation that requires the greatest care. Every particle of soft gelatinous tissue must be removed, and primary union must be ensured; if suppuration follows, the limb has nearly always to be amputated. A movable joint can usually be obtained, but splints are required for many years to prevent flexion.

Excision may be reserved for those cases in which the articular ends of the bones are too much involved, or in which, after the disease has subsided, the limb is practically useless, owing to the amount of flexion or of displacement of the tibia.

Tubercular Disease of the Ankle-Joint

Tubercular inflammation of the ankle-joint usually begins in the synovial membrane, but it may extend from the lower end of the tibia, or more rarely from the fibula or the astragalus. The general symptoms and treatment are identical with those given already, but there are certain points that require a little further detail.

The diagnosis is often a matter of great difficulty. The astragalo-scaphoid and astragalo-calcanean articulations are exceedingly close, and if they are diseased the symptoms are almost the same. Pain, heat, swelling, and limping, caused by impaired mobility of the part, are always present, and the greatest care may be necessary to separate disease of one joint from that of the other.

The swelling is most characteristic when seen from behind: it takes the form of a soft, puffy fulness, lifting up the extensor tendons in front, and occupying the hollows on either side of the tendo Achillis. Special attention should always be paid to this. Movement may appear to be free, but the foot can never be flexed or extended so far as the opposite one. Heat, muscular wasting, pain, and tenderness on pressure vary very greatly in different cases.

The diagnosis must be made from disease of the neighbouring bones, tubercular infiltration of other joints, and effusion into the sheaths of the tendons round the joint. In many cases, even when sinuses are present, it is almost impossible to make certain without exploration.

The treatment consists in perfect rest, combined with elastic compression, until all the tenderness and rigidity have subsided. The foot must be kept accurately at a right angle the whole time, or otherwise, if the joint does recover with a certain degree of stiffness, an operation may be required afterwards to correct it. Caseation may be treated by free incision and erasion with a sharp spoon, but arthrectomy or removal of the whole synovial surface is not so successful as it is in the knee. When the bones are involved an attempt must be made to open and drain the caseating focus; or if this is too extensive, and the disease is limited, excision may be tried, but the operation is not a very successful one and entails a protracted convalescence. Excision of the os calcis or astragalus sometimes succeeds; and if the anterior part of the foot is perfectly sound, osteoplastic resection after the method of Mikulicz is strongly recommended. The heel, with the astragalus, os calcis, and the soft parts over them, is removed entirely; the articular surfaces of the tibia and fibula above, and of the scaphoid and cuboid below, are sawn off, and the front of the foot is brought vertically under the leg, so that the toes assume the position of extreme equinus. MacCormac has performed this operation on several occasions with a very good result.

Finally, when the other bones of the tarsus are too much diseased, or the patient's health is beginning to suffer, or suppurative arthritis has set in, either Syme's or Tripier's amputation must be performed.

TUBERCULAR DISEASE OF THE SHOULDER-JOINT

Tubercular inflammation of the joints of the upper extremity (except perhaps the carpus) is more amenable to treatment. The articulations are smaller and more accessible; they have not the same amount of work to do, nor is the work so severe; and the patient can rest them more easily without being confined to bed.

In the shoulder-joint the inflammation usually commences in the synovial membrane; sometimes, however, the upper epiphysis of the humerus is almost excavated from the interior by masses of granulation-tissue. Owing to the freedom with which the scapula moves upon the thorax, the joint is kept at rest, and, as pain is rarely severe, the disease may almost run its course and lead to fibrous anchylosis without being noticed. The movements are awkward, especially overhand ones; there is a certain amount of tenderness on pressure, chiefly when the bone is affected; muscular wasting (particularly of the deltoid and supraspinatus) is very distinct; but suppuration is rare, and the gelatinous infiltration is seldom sufficiently extensive to cause much swelling.

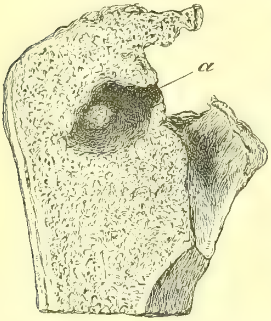


FIG. 260.—Sequestrum in head of humerus.

The local treatment simply consists in perfect rest; even the fingers should not be used until the active stage is passed. If, from the severity of the pain at night, or from the tenderness on pressure, there is a suspicion that the upper epiphysis is involved, the actual cautery may be tried; and if it continues in spite of this, an exploratory incision should be made down and into the bone from the outer side. Necrosis is rare, but occasionally the head is completely eaten away by fungating caries and caseation. If suppuration occurs in connection with the synovial membrane the pus usually makes its way under the deltoid either to the front or the back of the joint. Recovery is the rule, but even in the slightest cases a very considerable degree of stiffness is often left; fortunately the use of the limb is but little impaired, and it is rarely advisable to break down adhesions. Erasion and excision are seldom called for.

TUBERCULAR DISEASE OF THE ELBOW-JOINT

This is very common in children, and is usually assigned to accident; as a rule it begins in the synovial membrane, the epiphyses are not so frequently involved as in other bones.

The early symptoms are obscure and ill-defined. There is a little fulness on either side of the tendon of the triceps, the muscles of the upper arm are wasted, complete extension cannot be carried out, though the other movements may appear fairly free, and the joint is held rigidly flexed at an angle of about 135°. After a little time the fulness makes its appearance over the head of the radius on the outer side of the joint as well; the swelling becomes more distinct; rotation at the shoulder-joint replaces pronation and supination; the temperature of the skin is distinctly raised, and the diagnosis is beyond dispute.

As time passes the swelling of the case is neglected, grows larger and larger, until the joint is completely involved in a spindle-shaped mass the size of which is exaggerated by the wasting of the muscles; caseation sets in and is followed by liquefaction; the skin becomes thin and undermined; and at length the abscesses break externally, leaving sinuses filled with a mass of soft pulpy granulation tissue. Finally suppuration occurs and the pus makes its way into the synovial cavity, destroying utterly the cartilages and bones, which are already in great measure eroded and replaced by the tubercular deposit.

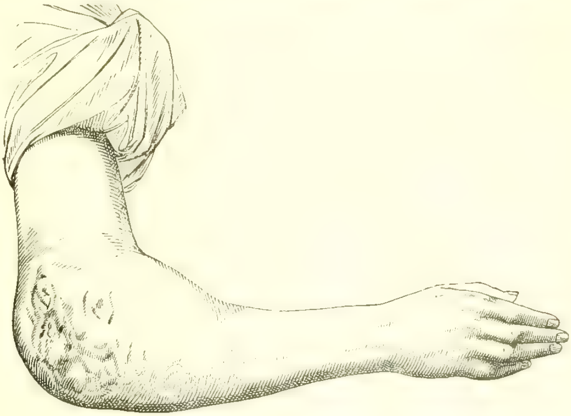


FIG. 261.—Disease of elbow-joint.

If the treatment is commenced at once, recovery may be looked forward to with a fair range of movement. The joint must be enveloped in cotton-wool and fixed with plaster-of-Paris or gum and chalk, so that not the slightest movement is possible. Scott's dressing may be applied underneath for a week or two, but care must be taken, especially in children, that it does not irritate the skin too much. If this is kept up for some months, the splints being changed as often as necessary, the inflammatory exudation disappears, and though the muscles waste considerably the joint is rarely much stiffened or seriously reduced in strength.

When the case is not seen until the disease is farther advanced the same treatment should be tried, but the hope of success is not nearly so good; at the best a large amount of the exudation must become organised, leaving the joint more or less rigid; and for this reason it is essential to maintain the flexed position. When abscesses make their appearance they must be opened and drained, or if they are limited in size and the tissues round them are fairly firm, they may be thoroughly scraped out and filled with iodoform. Finally, excision may be performed, either with the view of removing the whole tubercular mass, and therefore during the course of the disease, or afterwards, for anchylosis in a faulty position, especially as the results of this operation are exceedingly good even in the case of children.

Tubercular Disease of the Wrist-Joint

Disease of the wrist may begin either in the bones or the synovial membrane, probably in the former the more frequently of the two; but, whichever it is, it very soon extends until the whole of the articulation is involved. Certainly the majority of cases that I have seen have occurred after puberty, and many of them late in life.

The symptoms, as in tubercular arthritis generally, are peculiarly insidious. Limitation of movement is hard to detect, but it is usually present; wasting of the muscles of the forearm is one of the earliest signs, and a characteristic ill-defined swelling, which runs transversely over the dorsum of the wrist, obliterating the distinctness of the different tendons. At the same time there is a sense of weakness, the hand is rested whenever there is a chance, the joint is unconsciously flexed and slightly adducted, and the temperature of the part is distinctly raised, but pain is seldom present. If the case is left to itself the ordinary consequences—caseation, liquefaction and suppuration—make their appearance sooner or later.

Like the same disease when it affects other joints, tubercular arthritis of the wrist in its early stages is very amenable to treatment, provided it is carried out thoroughly, locally and constitutionally. The joint must be kept upon a splint, with even, equable pressure all round it, and not even a finger allowed to move for months, until the heat and swelling have entirely subsided; and even then it must be well guarded for fear of relapse. In the later ones, when caseation and caries have occurred, more good may be done in the same way, laying open and scraping out sinuses and removing carious portions of bone from time to time, than by any formal excision.

LOOSE BODIES IN JOINTS

Loose bodies of various kinds are occasionally met with in the interior of joints, giving rise to peculiar and very characteristic symptoms.

Some of them are like the melon-seed bodies found in bursæ and ganglions, mere concretions of fibrin which swell up on the addition of acetic acid, so as to become almost translucent, and show no other sign of structure than a faint concentric marking round a granular nucleus.

Whether blood effused into the cavity of the joint can give rise to loose bodies is somewhat doubtful; but there is no question that, sometimes at least, they originate as extravasations in synovial villi, which later become pedunculated and fall off into the synovial cavity.

By far the majority of these growths begin in the villi which are so common round the margins of the articular cartilages, where the synovial membrane is reflected upon itself, and are the result either of injury or of slight degrees of osteo-arthritis. This may account for the fact that they occur so frequently in young adults, and in the knee, which surpasses all other joints of the body to such an extent in the size of its synovial membrane and the range, variety, and immense leverage of its movements. The little projection, once formed, continues to enlarge; cartilage-corpuscles, which are so often met with in this situation that they must almost be regarded as normal, make their appearance in the end; and at length it assumes the form of a more or less rounded body, suspended by a narrow neck of fibrous tissue which may easily be torn across on any sudden movement. True bone is not unfrequently developed in the interior of the larger ones, the cartilage-corpuscles immediately round the osseous nucleus being ranged in vertical columns, and those near the surface flattened out, just as they are in the normal hyaline cartilage at the end of a bone. One of the most common situations is in the inter-condyloid notch of the femur; and then, unless it is dislodged, in process of time the abnormal growth wears out a bed for itself, so that it acquires the appearance of a portion of the articular surface broken away from the rest. As the cartilage is not unfrequently worn away from one side of it, leaving the bone exposed, the resemblance is exceedingly close. Humphry, however, has shown that, although this may possibly have happened in one or two instances as the result of a violent wrench, there is no proof of its ever having followed a blow. Even those that contain bone are nearly always developed from villi; they lie latent for years, slowly increasing in size and becoming more complex in structure; then suddenly they are dislodged from the cavity they have worn for themselves, and it is imagined they are just broken off. Their structure is not identical with that of the articular border. A certain amount of fibro-cartilage can always be found as well as true cartilage, and usually there is some trace of it on that surface which has apparently been separated from the bone by fracture. The osseous nucleus is irregular in outline, the bone-development imperfect, and the size often greater than that of the cavity from which it seems to have been broken out, so that when fitted in it rises above the surrounding level.

In exceptional cases loose bodies are derived from other sources. Osteophytes, for example, are sometimes accidentally detached from the margin of a bone affected with osteo-arthritis. Portions of the semilunar cartilages are torn off. In one instance the nucleus was found to be the point of a needle. In another there was a pedunculated sarcoma. Fatty outgrowths, almost detached, are not uncommon, and Paget, Teale, and others have described a process of quiet necrosis, in which pieces of the articular cartilage, with or without a portion of the underlying bone, exfoliate after injury, and drop into the joint, without causing any of the symptoms usual under such circumstances.

As a rule foreign bodies are single, especially when they occur after injury; in cases of osteo-arthritis there may be any number. For the most part the size is small, but they have been met with as large as the patella and even larger.

Symptoms.—A certain degree of uneasiness and weakness, caused by the increased synovial effusion, is usually present when there is a foreign body, whether it is loose in the interior of the joint or floating at the end of a pedicle; but the most striking effect is produced when it is caught between the bones. The patient, while in the act of walking, is suddenly seized with the most intense pain; all power of the limb is lost and he drops to the ground, very often sick or fainting; it has slipped between the articular ends, and, as the limb is straightened, it acts as a wedge, forcing them apart, straining all the ligaments, and crushing the cartilages. If it is fairly caught and held, the joint is locked and cannot be used again until the body slips out or is dislodged by manipulation; if, as it usually does, it just escapes, the patient is able to move the limb after the pain has subsided; but in either case the synovial cavity rapidly becomes filled with fluid, and an attack of acute synovitis, similar to that following any kind of sprain, sets in.

Generally speaking, the patient soon becomes aware of the presence of a loose body, and very often is able to find it by a little manipulation. The most common situation in the case of the knee is on the outer side of the joint, just above the condyle; sometimes they can be felt at once, at other times only with the greatest difficulty and after repeated examination, and they slip aside again as soon as they are found. If they are left, they may remain latent for months without causing a fresh attack; or they may be caught every day, and even several times a day. After a time the repeated attacks of synovitis lead to degeneration of the synovial membrane; it becomes thickened and covered over with fringes; chronic synovitis sets in, and the attacks are felt with less severity, but the condition of the joint is practically irremediable.

Hypertrophied fringes in osteo-arthritis, pedunculated masses of fat projecting from the ligamenta alaria or mucosum, and displaced or elongated semilunar cartilages, give rise to symptoms of the same character but less intensity. In the end, however, the synovial membrane of the joint becomes disorganised in the same way; movement becomes restricted and painful; and walking is almost impossible from the feeling of insecurity.

Treatment.—If the joint is locked the loose body must be dislodged by appropriate manipulation, and the effusion that follows checked by cold and pressure. As soon as the inflammation has subsided an attempt must be made to find the body (for which the assistance of the patient is usually necessary) and fix it in some outlying or superficial part of the joint. A very convenient way of doing this is to envelope the joint in a sheet of chamois leather spread with lead plaster, placed behind the limb, and then carefully brought up on each side of it. If this can be done the patient is safe for the time.

Except, perhaps, in the case of advanced osteo-arthritis, or when the synovial membrane is covered all over with masses of villi, there is no doubt loose foreign bodies should be removed as soon as possible; and the same may be said of many pedunculated ones when they can be isolated, as by their presence they merely tend to induce the same changes in the rest of the synovial living, until at length its condition becomes hopeless. The operation, if due precaution is taken to ensure absolute cleanliness, is exceedingly successful.

The limb should be placed upon a splint for at least forty-eight hours before, in order that the patient may become accustomed to it; the confinement alone is sufficient in many cases to cause a certain degree of feverishness. The skin, instruments, hands, &c., should be thoroughly cleansed with an antiseptic; the foreign body fixed, either between the finger and thumb, or by driving through it a straight needle and pinning it down to the bone (I have known it escape even then); and an incision made down on to it so that it may be squeezed out without manipulation. A catgut suture should be used to unite the synovial membrane; all hæmorrhage stopped; the edges of the wound brought accurately together; some iodoform dusted over the incision; and the limb replaced upon the splint and thoroughly packed all round so that there can be no hyperæmia or exudation. This should be left for a week; at the end of that time the wound is healed; the splint may be left off and the patient allowed to move the limb in bed, although the joint usually requires support for some time longer. When there are a number of loose bodies this is impracticable and the joint must be laid freely open and washed out. If any one of them is pedunculated, the incision should be made over it as nearly as possible so as to get at the pedicle and divide it.

Formerly an indirect method was occasionally employed. The synovial capsule of the joint was divided subcutaneously with a long tenotomy-knife, and an attempt made to force the cartilage through the opening into the subcutaneous cellular tissue, in which it would be left, either permanently or until the wound in the joint had healed. The operation, however, is very much more difficult to perform, and it has not been shown to possess any advantage in the way of safety.

ANCHYLOSIS

Anchylosis in the strict sense of the term signifies the angular position of a joint; but this meaning has long since been lost, and now it is used indiscriminately for articulations that have become stiff from organic changes in the structures immediately around them without reservation as to angle. It may be *bony* or *fibrous*, and the latter may be either *intra-* or *extra-articular*, although clinically it is often difficult to distinguish one from the other; but the term is not applicable to cases in which the limitation of movement is due to the contraction of structures not directly connected with the joint the cicatrices of burns, for example, or the degeneration of distant muscles), or those in which the cause is merely muscular spasm that disappears at once under an anæsthetic.

The distinction between true and false anchylosis should be dropped. The atter is used by some for simple muscular contraction, while, by others, it is restricted to cases in which there are definite organic changes in the tissues outside the capsule.

Causes.—Anchylosis is in most cases the product of inflammation; but nything that impairs the nutrition of a joint for any length of time—proonged confinement, for example, in one position, or section of the nerves oing to it—is liable to produce it. Perfect movement naturally cannot take lace without perfect nutrition, so that a certain degree of stiffness is intelliible under these conditions; but it is difficult to explain the bony union which has been known to occur.

The degree of rigidity depends to some extent upon the character of the nflammation (chronic rheumatism, for example, has a special tendency towards rganisation and rigidity), but much more upon the depth to which the ssues of the joint are involved. In sprains the loose and soft cellular tissue utside the capsule, the ligaments and surrounding muscles usually suffer nost, so that the chief obstruction is extra-articular; the interior of the ynovial cavity may, it is true, be filled with blood; but, except in those cases in which it becomes organised as a lining membrane, it seldom causes any after-trouble. Chronic rheumatism attacks the fibrous structures chiefly, so that the capsule, ligaments, fasciæ, and tendon-sheaths around are welded together into rigid unyielding bands. In urethral arthritis and the acute form of osteo-arthritis, intra-articular changes generally occur as well, the cartilages undergoing fibrous degeneration at their margins and growing together so as in great measure to obliterate the cavity. Sometimes the union is so firm that it is almost impossible to believe it is not osseous. Tubercular arthritis presents every grade of anchylosis. If the disease is limited to one part of the capsule, or to the periarticular tissues, the rigidity is comparatively slight. If the ligaments have been softened and have contracted again, and if the margins of the cartilages have been invaded by granulations springing from the synovial folds, the range of movement is much more restricted; but if the disease has progressed farther still before repair and organisation began, and the surface of the cartilages has been destroyed and the bones laid bare, the rigidity becomes absolute; dense intra-articular adhesions pass across the joint in all directions, and not unfrequently as time passes become converted into bone. The same thing occurs in suppurative arthritis; if the cartilages are preserved, and the disease is limited to the capsule and the peri-articular tissues, a fair range of movement may be regained; but, if once the ends of the bones are laid bare and become carious, osseous anchylosis, or union by such dense fibrous tissue that it can scarcely be distinguished from it, is almost certain.

Prolonged confinement in certain positions may cause serious stiffness, and in one or two instances has resulted in total obliteration of the joint-cavity. As, however, the limbs in young children are often held rigidly fixed for years together without any such result, rest is probably not the only factor. It is most frequent in connection with the finger-joints and in patients who are already past middle life: the application of a straight splint in such cases, even for a week or two, may be followed by a degree of rigidity that requires as many months before it disappears; and this may occur without injury of any kind and in the entire absence of evidence of gout or rheumatism. Over-extension, causing slight but persistent tension upon one part of the capsule, may be the cause; the irritant is a feeble one, but it may be sufficient, under the conditions, to impair the nutrition of the tissues, and make them dense and rigid, unable to yield on one side or bend upon the other. The same thing has been noted on several occasions after nerve-section.

After sprains and other injuries when the tissues are filled with extravasated blood, and in patients who are subject to attacks of rheumatic gout, prolonged repose without massage or passive motion is almost certain to cause some degree of fibrous anchylosis. The lymph that fills the softened synovial folds becomes organised into dense cicatricial tissue; the capsule grows hard and thick; the ligaments shorten and become rigid; the tendons are glued to their sheaths; and all the peri-articular tissues are matted gether. In a few instances the change is not limited to this: the cartilages become fibrous, and fuse where they are in contact with each other; intra-articular adhesions are formed as well; and sometimes even bony anchylosis follows.

The pathological changes in a case of anchylosis are the result partly of inflammation, partly of atrophy. When there is bony union, the fusion may be so complete that even the site of the joint-cavity can no longer be traced. The trabeculæ are arranged as uniformly and as regularly along the lines of pressure as if the joint had never existed at all (fig. 262). The muscles undergo fatty degeneration and waste away; the ligaments disappear or become ossified; and no sign of capsule, synovial membrane, or cartilage is left; there is merely an irregularly thickened fibrous mass surrounding the periosteum where the joint originally was. In the fibrous form the wasting is less marked, depending upon the range of movement left; but in those cases of intra-articular anchylosis in which the greater part of the cavity of the joint is filled up by short dense fibrous bands, mixed here and there with cartilage-cells, the difference is very slight. Even when the change falls short of this the capsule is thickened and rigid, especially along the inner side of the joint where it is thrown into folds when the limb is flexed; the ligaments contracted; the fibrous tissue around converted into a dense unyielding mass; the cartilages wasted and thinned; the tendons glued to their sheaths; and the skin bound tightly down by the wasting of the cellular tissue beneath, as if it were shrunken on to all the bony prominences. Sometimes all these changes exist together; sometimes there is only a single adhesion inside the joint-cavity, the tip of a synovial fringe for example, tied down by a fibrous band to some distant part of the capsule; and often it is impossible to say what the condition of the joint may be, and how far it is involved, without placing the patient under an anæsthetic and ascertaining the range of movement and the strength of the obstacles that prevent it.

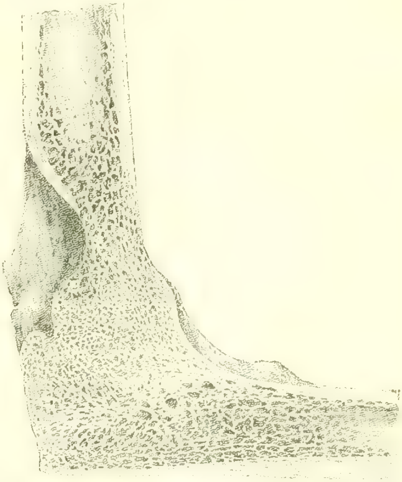


FIG. 262.—Osseous anchylosis of elbow-joint.

Diagnosis.—Bony anchylosis can usually be diagnosed by the extreme muscular atrophy and the entire absence of pain even when the part is roughly manipulated. If there is the least degree of mobility left, too small to be appreciated by the hand, the muscles round the joint involuntarily start into spasmodic contraction as soon as any force is used; with bony anchylosis they remain absolutely flaccid. The distinction between intra- and extra-articular rigidity turns rather upon the cause than upon any symptom that may be present; it is rarely possible to be certain, but probably the former is seldom met with by itself.

Treatment.—*Bony anchylosis.*—In many cases this is the best result that can be obtained under the circumstances, and, provided the position is good, it should not be touched. If, for example, the elbow is flexed to a right angle (or preferably a little less) the hand can be used for all ordinary purposes with perfect freedom; when it is more open, so that the fingers cannot be brought to the mouth, it becomes a question whether excision should not be performed. The hip and knee when nearly straight impair the power of the limb very little, although the gait is awkward; if, however, they are much flexed, excision (removing a wedge-shaped piece) should be performed in the one case, osteotomy (either through the neck or below the trochanter) in the other. In the case of the shoulder, ankle, and fingers, neighbouring joints compensate so thoroughly that active treatment is rarely necessary. Bony anchylosis of the temporo-maxillary articulation, on the other hand, naturally cannot be left.

Fibrous anchylosis.—The function of the part may be restored, or at least improved, by stretching the adhesions, or forcibly breaking them down. Nothing, however, may be attempted so long as there is the least degree of inflammation; it would merely cause a fresh attack, the danger that is feared the most.

The probability of inflammation depends chiefly upon the nature of the original cause. If this was traumatic—if, for example, the joint was sprained or dislocated, and the injury repaired at once—the risk is exceedingly small; breaking an adhesion across, once for all, in a healthy person, is not more likely to cause inflammation than breaking a bone. If, on the other hand, it was constitutional, whether due to gout, rheumatism, tubercle, or any other cause, and the same diathesis is present still, there is no question that violent manipulation may be followed by very serious results. Fortunately, even in these cases, the predisposing causes are not always of the same intensity: gout and rheumatism, for example, admit of being alleviated; and, especially in the case of joints and bones, the susceptibility to tubercle is of limited duration; so that, by selecting a proper time, when the general health is good and the skin over the affected joint perfectly cool, and by adopting suitable precautions before and after, a very great deal may be effected in the vast majority of instances with the minimum of risk.

The other question, whether the adhesions should be broken down once for all (under an anæsthetic if necessary), or gradually stretched little by little until they give way sufficiently to allow free movement, is more easy. This depends almost entirely upon their extent. If they are small and few in number, or if they are so situated that they can be taken one by one—round the capsule of a joint, for example—and snapped across by successive rapid action, the chance of inflammation following is very much less than if they are strained each day by the application of some continuous force, and recovery is more perfect. It is mainly owing to their skill in localising lesions of this kind in the neighbourhood of joints, and to the experience they have gained in the necessary manipulation, that bone-setters have acquired so great reputation with many people, in spite of their frequent failures, and in not a few cases disastrous results. Very little, on the other hand, can be done in this way in the case of the short and dense intra-articular adhesions that form after suppuration or advanced tubercular disease. These may be stretched to a certain extent by continued traction so as to alter the position of the limb if that is faulty; but, as a rule, any attempt at restoring mobility by more active measures is only too likely to end in failure.

Tenotomy is rarely required in cases of fibrous anchylosis, except for distant tendons or thickened portions of the fascia that have undergone passive contraction. The punctures should always be allowed to heal soundly before the least manipulation or extension is attempted for fear of the skin giving way.

Whichever plan is adopted, it must always be remembered that tearing, stretching, or cutting the resisting bands is only half the cure. Owing to prolonged rest, all the structures around the joint are wasted, stiffened, and incapable of work, and, after all gross mechanical obstacles have been removed, these must be brought into a thorough state of nutrition before they can be expected to work freely and painlessly. The joint must be well steamed and douched; all the tissues kneaded thoroughly and well rubbed with oil; the muscles manipulated and stretched; and passive and what are known as resistive movements assiduously practised.

Section VI.—Excision of Joints

By excision is understood the formally-planned removal of more or less of the articular surfaces of a joint, not merely the synovial membrane (erasion) or the part that is obviously diseased. It may be required either for injury (this is sometimes distinguished as primary excision), disease, or deformity.

(*a*) *In cases of injury*, excision is performed as an alternative to amputation. Except at the hip-joint, it is the more serious operation of the two, entailing prolonged confinement, and should not be preferred unless the age and constitution of the patient (particularly the state of the kidneys) are favourable. It is essential that the main blood-vessels and nerves of the part should be intact, and the skin not too much bruised.

(*b*) *For disease.*—Tubercular arthritis is the most frequent cause, osteo-arthritis an exceptional one, and other forms of disease still more rare. For it to succeed, the inflammation must be chronic or past; the age of the patient suitable; the viscera sound (without amyloid degeneration, or, at the very most, a suspicion of it); the bone not too extensively diseased (if the epiphyses are cut away the growth and utility of the limb are so much impaired as to raise the question whether amputation would not have been better); and all the soft parts involved capable of free removal.

(*c*) *For deformity.*—This may be the result of injury, or of antecedent inflammation—septic, tubercular, or rheumatic—or in some rare cases it may be congenital. The question here is an entirely different one, depending upon the utility of the joint in its deformed position; the probable utility of the part after excision, judging from previous experience; and the possibility of rectifying the deformity more or less completely by some less serious operation, such as subcutaneous osteotomy.

General principles.—The soft parts are incised in such a way as to expose the interior of the joint with the minimum of injury to the structures around. The epiphysial lines must be kept intact. How much bone is taken away (beyond that which is diseased) is regulated by the kind of union that is required, bony or fibrous. The whole of the disease must be removed; if there are outlying sinuses or tubercular foci in the bones, they must be thoroughly scraped out. Perfect drainage must be provided for, and the dressing and splints must be arranged so as to keep the part at rest and exert sufficient pressure upon it, while at the same time they admit of being changed, if required, with the minimum of disturbance. Passive motion, if enough bone has been taken away, need not be commenced until the wound is practically sound; but where, as in the case of the wrist, tendons that move other joints have been exposed and handled, these should be worked after the first day in order to prevent the formation of adhesions.

The preservation of the periosteum is only to be attempted when a great reproduction of bone is advisable. If the bones are soft and inflamed, as in most instances of tubercular arthritis, its separation presents no difficulty, but in primary excisions it adheres so closely that very often it is too much bruised to live.

In cases of fibrous union and when movement is desired, massage, shampooing, and galvanism should be commenced as soon as possible. The muscles and nerves are atrophied from prolonged disuse, the circulation through the limb is very feeble, and it requires much time and patience to bring back the part to its normal state of nutrition.

EXCISION OF SPECIAL JOINTS

I. The Upper Extremity

Excision of the Shoulder-Joint

This may be required for injury or disease. Ankylosis is compensated for so thoroughly by the mobility of the scapula that it is a question whether operation is advisable. It has also been performed for unreduced dislocation in which the head of the bone was resting upon the brachial plexus, and for tumours in connection with the upper extremity of the humerus.

(*a*) *Injury.*—In this case the operation merely consists in removing comminuted, displaced, and detached fragments of bone through the wound (enlarging it if necessary), cleansing the cavity thoroughly, and providing free drainage.

(*b*) *Disease.*—Tubercular ostitis of the head of the humerus, involving the synovial lining secondarily and spreading to the glenoid fossa, is the most frequent cause; but, even in this, expectant treatment, removing carious or necrosed fragments of bone and scraping out old sinuses, is usually followed by such a good result that excision is seldom practised. For other forms of inflammation—osteo-arthritis, urethral arthritis, acute necrosis, or chronic suppuration—it is still more rare.

The usual incision is vertical, between three and four inches in length, beginning just outside the coracoid process, on a level with it, and carried through the skin, fascia, and deltoid down to the bone. If the arm is rotated outwards and the soft parts drawn to the sides, the tendon of the biceps is exposed at the bottom. This should be preserved if possible; sometimes it is in a pulpy condition, or has already been eroded, and occasionally it is fixed firmly to the bone in its groove, and the upper end of it lost. The capsule is then freely opened and the condition of the parts examined before determining how much it is necessary to take away.

So far as the subsequent utility of the limb is concerned there is no doubt that the more of the bone that is left the better. Partial resections (in which some of the head is left, the rest being gouged away) give better results than when the anatomical neck is divided; and this is to be preferred to the surgical neck. The whole of the disease must be removed (and in cases of tumours springing from the head of the bone one-third and in some cases even more of the shaft has been excised, preserving the elbow and the hand), but, consistently with this, as little as possible of the healthy bone. The question of subperiosteal excision is still open, but there is ground for believing that where it is practicable the results are superior to the other method.

If the surgical neck requires division the arm must be strongly rotated outwards by the assistant as soon as the capsule is opened, in order that the tendon of the subscapularis may be cut; and then inwards for the short external rotators. As soon as this is done the head of the bone rises well up into the wound, and may be either sawn off with a narrow-bladed saw *in situ*, the soft parts being protected and held aside by retractors, or thrust bodily out. The glenoid fossa very rarely requires more than the application of a gouge.

A counter-opening at the back of the joint is usually advisable for drainage. The wound is thoroughly cleansed; the margins drawn together with sutures; a large tube placed across it; and the cavity of the axilla, the space behind the shoulder, and the outer side and front of the arm thoroughly packed with wood-wool. Stromeyer's elbow-cushion should be used as long as the patient is in bed, and passive motion commenced as soon as the condition of the wound allows it, the fingers and wrist being exercised from the first.

Results.—All underhand movements can be carried out exceedingly well; elevation above the horizontal line is only possible in those cases in which the head of the bone is partly preserved or reproduced; in all others the deltoid loses its fulcrum, and the perfect apposition of the two bones, which enables rotation of the scapula to raise the arm, becomes impossible.

Excision of the Elbow-Joint

Primary excision for compound comminuted fracture extending into the joint is very successful. As usual in primary operations, the reaction is greater than in the cases of disease; and if suppuration occurs a very large amount of callus may be thrown out, endangering the movement of the joint. It is chiefly required when the lower end of the humerus is comminuted. When this occurs it is practically impossible to restore the fragments to their proper position, and owing to the irregularity of the articular surface and the filling up of the coronoid and olecranon fossæ, a much wider range of movement can be obtained by operation.

Excision for disease.—Tubercular arthritis is the usual cause, but the proportion of cases in which the operation is required is a very small one. Strumous disease of the elbow-joint is essentially an affection of childhood, a time in which excision should if possible be avoided, owing to the way in which it interferes with the growth of the arm; and in the vast majority of instances, if the patient's surroundings can be improved, the joint kept at rest upon a splint, abscesses opened from time to time, and sinuses and carious bone scraped out, the result is an exceedingly good one. The range of movement, it is true, may not be so wide; but if proper attention is paid to position, it is usually sufficient, and there is no risk of a 'flail-joint,' or of failure of growth. There is certainly the danger of the tuberculosis becoming general, but it rests with the advocates of excision to prove that this is serious. Of course, if the bone is so extensively diseased that repair is unlikely, or if improvement does not take place under ordinary treatment, or if the amount of discharge is so great that there is risk of the general health failing, there should be no hesitation.

For other diseases excision is rarely necessary; but it may be performed for suppurating osteo-arthritis (in a patient sixty-three years of age under my care the result was most successful) and for chronic suppuration consequent upon injury or pyæmia.

In cases of deformity, whether arising from old unreduced dislocation, from anchylosis after inflammation, or from cicatricial contraction of the soft parts, excision often gives a very good result. The question as to its advisability turns upon the usefulness of the arm and the occupation of the patient. Bony anchylosis at an angle of 75° to 80° is a wonderfully slight impediment to many people: on the other hand, if the angle is in the least degree obtuse, so that the patient can neither feed himself with an ordinary spoon or fork nor place his hand at the back of his head, the arm is almost useless.

Operation.—An elastic band may be applied round the arm, but the bleeding is usually slight. The shoulder is raised on a pillow and the forearm held by an assistant. If the right elbow is in question, the arm should be held across the patient, with the olecranon presenting upwards, the operator standing on the same side, the assistant on the opposite one. If the left, it is more convenient for the surgeon to stand upon the right. A linear incision, four inches in length, is made over the back of the joint, its centre corresponding to the tip of the olecranon. It should lie just to the inner side of the middle of the arm and be carried right down to the bone at once, splitting the fascia of the triceps longitudinally. The next step is to detach from the bone the aponeurosis covering the back of the olecranon, first upon the outer side, then upon the inner, until the narrower part of the process is reached. In cases of disease this is easily accomplished with a blunt elevator; but in primary excision it is more difficult. If now the olecranon is cut across with a pair of bone-forceps, the cavity of the joint is opened, the triceps and the posterior parts of the lateral ligaments are detached from the ulna, without risking the insertion of the muscle into the fascia, and abundant space is obtained for separating the soft parts from the condyles.

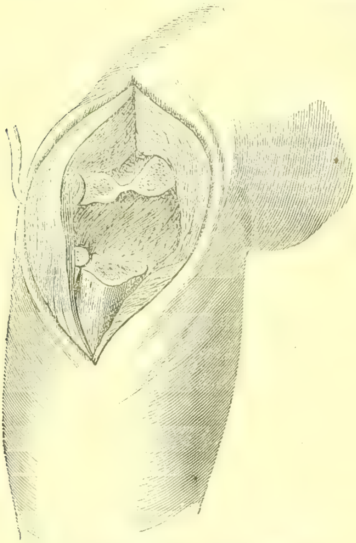


FIG. 263.—Section of the bones in excision of the elbow-joint.

This, especially in cases of injury, is the most tedious part of the operation. The inner side must be cleared first, taking care of the ulnar nerve, which is seldom seen. The soft parts are raised with the thumb from the bone beneath, and carefully separated from their attachment with a stout scalpel, keeping the knife parallel to the nerve. The external is treated in the same way, the assistant helping by keeping the arm as nearly vertical as possible. As soon as this is done the end of the humerus protrudes through the incision and the bone can be cleared with ease as high as necessary. How much should be removed depends upon the general condition; the whole of the cartilaginous surface should certainly come away, the line of section passing above the condyles; but the age of the patient, the cause, whether injury or disease, and the state of the arm, which in some cases of old anchylosis is greatly wasted, must all be taken into consideration.

The stump of the olecranon and the head of the radius are then cleared in the same way and sawn across together, above the insertion of the biceps. It is often recommended to open the joint above the olecranon, and remove the necessary portions of the ulna and radius first; but I have found the method described more expeditious.

In tubercular disease the condition of the synovial membrane and of the bones may require attention. One or two small arteries may need to be tied or twisted, but there is very little bleeding. The wound can usually be washed out at once with a hot solution of corrosive sublimate, and sutured, leaving an orifice in the middle for drainage, or better, a short drainage-tube.

Many splints have been devised for use after this operation (some surgeons use none at all); but as convenient a contrivance as any, at least while the patient is in bed, is an inside angular one, interrupted and hinged opposite the elbow, provided with a rounded end (as in Carr's splint) for the fingers, and with two cross-bars underneath, so that it may be slung from a pulley over the bed and supported by a counterpoise of shot. With this the dressings are easily changed; the angle can be altered if required; the fingers can be exercised; and the patient can sit up and move about in bed, without the least fear of disturbing the wound.

Passive movement of the fingers and wrist should be commenced at the end of the first week; the new joint need not be moved until the wound is nearly sound. If too little bone has been taken away, passive motion will not prevent osseous union. In some cases all the movements of the joint—flexion, extension, pronation, and supination—are almost perfect from the first; but these are the exceptions. In the majority there is very little power for some time, but gradually, as the muscles grow accustomed to their shortened position, and as the nutrition improves under the influence of galvanism, massage, passive motion, and exercise, the strength returns and the range increases until it is almost, if not quite, as good as in the normal arm. This may take place even after a twelvemonth.

If the movement becomes restricted, in spite of passive motion, the question must be considered whether the operation should be repeated and more bone removed, or the limb allowed to become rigid (as it cannot be prevented) at the most convenient angle. If, on the other hand, a flail joint results, the usefulness may be greatly increased by providing the patient with a suitable leather or poroplastic splint, taking the whole of the arm and the forearm as far as the wrist.

Excision of the Wrist

This is very rarely required except for strumous disease. I have on several cases performed a partial operation in cases of injury, removing bruised and broken fragments of bone with a good result; but an accident that rendered complete excision necessary would almost certainly cause too great destruction of the soft parts.

It may be performed in various ways, but the two chief are those practised first by Lister and by Langenbeck.

1. *Lister's operation.*—Two lateral incisions are made; the whole of the

carpal bones except the hook of the unciform and the osseous portion of the pisiform are removed, and five tendons only (the carpal flexors and extensors) divided at their insertion.

Esmarch's bandage is applied and the adhesions broken down. The first incision begins on the middle of the dorsal aspect of the radius, on a level with the styloid process, and runs thence to the radial side of the base of the second metacarpal and along the bone for half its length. Its first part lies just internal to the extensor secundi internodii, and it turns just before it reaches the radial artery. If carried down to the bone at once it necessarily cuts across the extensor carpi radialis brevior; this may, however, be avoided with a little care and the tendon divided immediately afterwards at its insertion.

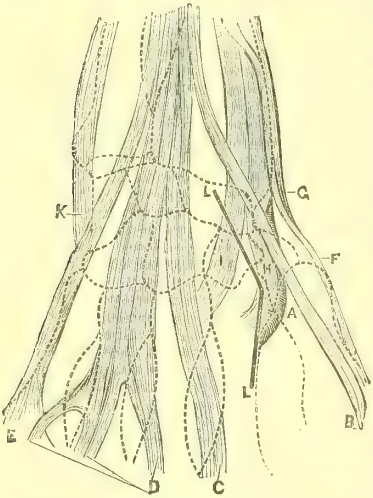


Fig. 264.—Lister's incision for excision of the wrist.

The tendon of the long extensor of the carpus is then separated from its attachment; the radial artery with the tendons of the thumb drawn outwards; the trapezium detached from the rest of the carpus with cutting-forceps, and all the tendons on the dorsal surface of the carpus raised from the bones beneath as far towards the ulnar side as possible. They should not be lifted out of their grooves on the radius.

The second incision is on the palmar aspect of the ulnar side. It begins two inches above the joint, internal to the flexor carpi ulnaris, and is carried down to the middle of the fifth metacarpal. The tendon of the extensor carpi ulnaris is cut at its insertion; the dorsal and internal lateral ligaments divided, and the raising of the extensor tendons completed by working towards the radial side.

The soft parts on the palmar surface are separated next, the pisiform bone with the tendon of the flexor ulnaris being detached from the rest and the unciform process cut off. The wrist in doing this must be flexed and care must be taken not to work down on to the metacarpus for fear of the deep palmar arch. The anterior ligament of the carpus is divided at the same time.

The carpal bones (except the trapezium) can now be extracted through the ulnar incision with sequestrum-forceps, the ends of the ulna and radius forced out, and their articular surfaces removed with a gouge or saw, as the case requires. The styloid process of the ulna should be left, and the tendons on the dorsum of the radius disturbed in their grooves as little as they can be.

The metacarpus is then treated in the same way: the trapezium dissected out, taking care of the tendon and the artery (if this bone appears fairly sound it may be left), and the articular surface removed from the pisiform bone.

Lister's splint, with a cork pad to support the fingers in semi-flexion, and a bar for the thumb, is nearly always used. The fingers and thumb must be thoroughly flexed and extended at every joint after the second day, in order that the tendons may cut channels for themselves in the vascular lymph that fills the wound; but the wrist itself must be kept at rest until union is assured.

2. *Langenbeck's.*—A single incision four inches in length is made along the dorsal surface of the wrist between the tendons of the extensor secundi internodii and the extensor indicis, commencing well above the wrist-joint and ending at the middle of the second metacarpal bone on its ulnar side. The tendons on the radial side of the incision are then lifted up from the radius and the carpus, with the periosteum, so that the sheaths are not opened; the proximal row of carpal bones separated from each other and extracted one by one, beginning with the scaphoid, and then the second row treated in the same manner. It must be remembered that in cases of strumous disease the bones are softened; the ligaments for the most part easily divided; and the soft tissues around matted together so that they can be much more easily detached; otherwise this operation is one of considerable difficulty.

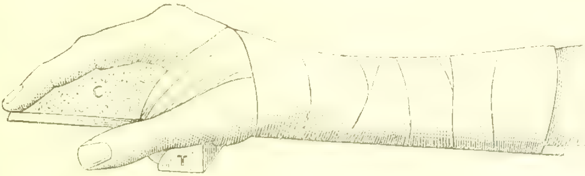


FIG. 265.—Lister's splint for excision of the wrist.

The cases for which excision of the wrist is required are few and far between. In young subjects, if caseation is not yet far advanced, a very great deal can be done by rest, tonics, and thorough general treatment, the joint being easily protected afterwards. If caseation and suppuration have occurred already, local operations, such as gouging out soft carious bone and packing the cavities with iodoform gauze, frequently suffice, and leave a very useful hand. In older people it is so often associated with phthisis that great care must be taken in the selection of cases. The operation itself sometimes yields a very good result; but, on the other hand, not unfrequently all the tendons become matted together, or the tubercular disease returns, or suppuration sets in, or the patient's health begins to fail and amputation has to be performed. In what proportion of cases this occurs it is impossible to say, but there is reason to believe that it is a very large one.

The Thumb and Finger Joints

Excision of the metacarpo-phalangeal articulation of the thumb may be performed without difficulty through a vertical dorsal incision. It is sometimes required for compound comminuted fractures or old unreduced dislocations, and gives an excellent result. Occasionally a similar operation is advisable in injuries of other joints.

II. THE LOWER EXTREMITY

The Hip-Joint

Excision of the hip is performed for compound comminuted fractures of the head of the bone (such cases are very rare in civil life) as an alternative to amputation, and occasionally for old unreduced dislocations. The total number of these, however, is very small: nearly always, when excision of the hip is mentioned, the presence of tubercular arthritis is implied.

The operation may be performed either through an anterior or a posterior incision; the former is preferred if the disease is in its earlier stages, before suppuration has occurred, and when there is reasonable hope of securing primary union; the latter if the parts are disorganised and a large amount of discharge expected.

(1) *The anterior method.*—The patient is placed on his back with the limb slightly flexed. The incision, three or four inches in length, is begun immediately below the anterior superior spine and carried downwards and a little inwards, parallel and just external to the sartorius, so as to open up the capsule of the joint at once between this muscle on the inner side, and the tensor fasciæ femoris and the glutæus medius on the outer. A deeper incision is now made in the capsule, parallel to its fibres; the soft parts are pushed on either side with an elevator, the finger introduced to examine the part, and a narrow-bladed saw passed down by its side on to the top of the neck. As soon as this is divided the head of the femur is grasped with a pair of forceps and twisted out. If the acetabulum or the great trochanter is involved, the carious bone is gouged away, and any caseous deposit in the neighbourhood thoroughly scraped out. Then the wound is washed out with a hot antiseptic solution; dried thoroughly; dusted with iodoform and sewn up, leaving a drainage-tube of suitable size. As Barker has shown, the actual cavity left by this operation is a very small one, and in a certain proportion of cases primary union can be obtained. This, however, is only practicable in the earlier stages of the disease.

(2) *The posterior method.*—The patient lies upon the sound side near the edge of the table. The incision, three to four inches in length, begins about midway between the anterior superior spine and the great trochanter, and, as Jacobson recommends, is carried downwards over the middle of the latter, so as to end upon the shaft. If it is taken round the trochanter, it encroaches upon the substance of the muscles. The capsule is opened freely by deepening the incision; the soft parts are separated from the bone with an elevator, the periosteum as a rule coming away without difficulty, and as soon as the parts are sufficiently free the neck is divided with a key-hole saw. The finger should be used to protect the soft parts on the inner side. Afterwards the condition of the acetabulum must be examined; any sequestra that are present removed; and if there is any evidence of a pelvic abscess (which may often be ascertained previously by rectal examination) sufficient of the floor taken away to ensure thorough drainage.

If the great trochanter is carious it must of course be scraped out; but some surgeons remove it as a matter of principle, no matter what its condition may be, on the ground that it interferes with drainage, and that, as the lesser trochanter always rises up into the acetabulum, it does not add to the length. Jacobson, moreover, is of opinion that it tends unnecessarily to irritate the scar-tissue. It must, however, considerably increase the strength of the limb.

The after-treatment, whichever incision is practised, consists in perfect rest in a position of extension with slight abduction. In the case of the anterior a Thomas' splint may be applied after the first week.

The indications for this operation have been discussed already. By some surgeons it is performed as soon as caseation is certain; by others only as an alternative to amputation, when it is clear that the recuperative power of the patient unaided is incapable of dealing with the disease. The difference in opinion appears to have arisen chiefly from the difference in the conditions under which the patients are placed.

The results of the two operations naturally differ very greatly. An excellent limb is left after early excision, if the wound heals up at once; if it does not, and there is reason to believe that primary union is not invariable, the condition of the patient is very serious; but as yet hardly anything is known with regard to the ultimate effect, and this of course is the true criterion. Late excision undoubtedly leaves a wasted and shortened limb, but the credit of this must not be laid wholly at the door of the operation; had this not been performed, it is questionable whether the limb would have been any better, and it is quite possible that the patient would not have survived the prolonged suppuration without some amyloid degeneration. The comparison, if there can be one, should be made, not between the results of early and late excision, but between the results of early excision on the one hand, and those of the natural process of cure with a very few cases of late excision on the other.

Excision of the Knee-Joint

Primary excision has been performed in a few cases of gun-shot wounds, but the conditions under which so serious an operation is admissible are very rare. Chronic disease involving the bones is the general cause (erasion or arthrectomy is to be preferred as long as the soft parts only are concerned); osteo-arthritis, limited to one joint in a patient otherwise healthy and not too old; anchylosis in a faulty position, and compound transverse fractures of the patella, in which it is impossible to bring the fragments together without shortening the limb, are occasional ones.

Operation.—Many different incisions are recommended by different operators, depending partly upon the advisability of removing or leaving the patella. The ordinary one is semi-circular in shape, the bone being taken away.

It commences behind the condyle on the side that is farthest from the operator, passes down over the ligamentum patellæ, and is continued up to a corresponding point on the opposite side. The lateral ligaments are divided, but it should stop short of the internal saphena vein. The flap thus marked out is then reflected upwards and the joint freely opened by a second incision convex upwards, starting from the extremities of the first and carried through the tendon of the quadriceps above the patella. In many instances it is advisable to slit the tendon up still higher by a vertical incision in the middle line. The whole of the great suprapatellar pouch must be exposed and thoroughly scraped out, and in the case of children suffering from chronic disease of the synovial membrane it not unfrequently extends nearly half-way up the femur.

The other incisions are transverse across the patella, opening the joint above and below the bone and removing it at once; transverse, dividing the patella in two, so that it may be wired together again afterwards (this helps to prevent displacement of the tibia backwards, but it renders the complete removal of all the pulpy tissue more difficult); and semilunar, across the tubercle of the tibia. This process belongs to the epiphysis and can easily be separated with a chisel (in many cases a stout scalpel will answer) carrying the ligamentum patellæ with it, so that the whole of the front wall of the knee-joint is reflected in a single flap. Afterwards, if the patella is left, it may be fixed down again by means of a wire or chromic catgut suture.

As soon as the joint is freely opened the suprapatellar pouch must be cleared out, the rest of the soft structures being dealt with later. The femur is then pushed as far on the surface of the tibia as possible (the popliteal artery is well out of the way); a cut made through the soft tissues covering it for the saw, and the articular surface removed, the line of section being at right angles to the shaft (a little more usually has to come away from the inner side than from the outer) from above downwards and slightly from behind forwards. Butcher's saw may be used, but an ordinary one answers as well. The level of the epiphysis is marked by the adductor tubercle, and the incision should not be carried above this; if the disease extends higher it must be scraped or gouged away.

The position of the bones is then reversed, the tibia brought in front of the cut section of the femur and the upper surface with the semilunar cartilages resting upon it sawn off. As a rule it is sufficient to remove the articular lamella; if there is a soft or carious spot in one of the tuberosities it can be gouged out and an opening for drainage made through its base on to the anterior surface of the bone. The anterior crucial ligament must always be sacrificed, but in many cases it is possible to preserve the attachment of the posterior one, and if this can be done it renders the bones much more secure.

After this the synovial membrane covering the posterior ligament and that which lines the posterior pouches (often in these cases very much increased in size), can be dissected off or scraped away without difficulty. Every particle of soft tissue must be removed, as persistence of the tubercular growth is one of the main causes of failure.

If the posterior crucial ligament has been preserved the bones are fairly secure without anything else. Where it has been divided the cut surfaces may be sutured together with steel pins driven obliquely through both bones so as to cross each other near the line of union, or with wire, silk, or stout chromic gut. Afterwards one or two drainage-tubes must be inserted according to the amount of discharge expected, the wound thoroughly washed out, all bleeding stopped, and the anterior flap adjusted and fastened down. A back splint, interrupted opposite the knee, and provided with a foot-piece to prevent any drooping of the toes, must always be used. It may be made of wood or of tinned iron, and it should be provided with two cross-bars, so that it can be slung from a pulley over the bed and supported by a counterpoise of shot. If this is well adjusted and the mattress cut away on the diseased side from below the fold of the buttock, the limb swings absolutely free, entirely out of the patient's control. It may be secured either with two interrupted side-splints like an ordinary compound fracture, or with a mixture of paraffin and wax applied hot, as recommended by Howse. In either case the fixation is absolute. Union is fairly sound in a successful case at the end of six weeks, and the patient may then be allowed to get about on crutches, the limb being protected either with a poroplastic casing or with Thomas' knee-splint. Some appliance of this kind must be worn for several years, in the case of children until the period of growth has ceased.

The details naturally require modification in many particulars. The patella, for example, is sometimes preserved, its articular surface being thoroughly gouged away; or it is divided and sutured together again. Sometimes it is sufficient merely to shave off the ends of the bones; and occasionally the bones themselves can be left untouched, only the soft pulpy synovial tissue being removed, as in erasion; but when this is done great care is required to prevent flexion afterwards.

Results.—Excision of the knee rarely succeeds in patients over thirty years of age, or in those under ten; in the former the reparative powers fail, in the latter the growth of the limb is too much impaired. Puberty is the most favourable time. In some few cases a movable joint has been obtained (in erasion, in which the articular surfaces are not taken away, this is usually the case, and sometimes the range is nearly as good as the normal one), but it is certainly wiser to try for bony anchylosis. Failure may occur from the whole of the tubercular disease not having been removed, from the strength of the patient being unequal to the strain, or from too much bone having been taken away. In this case, even if union does take place, the limb remains so weak and wasted and is so much shorter than the other, that amputation is usually preferred. Later, even after years have passed, the osseous union sometimes yields and causes serious deformity.

Excision of the Ankle

This operation is rarely practised; the reparative power of the foot is not very great, stability and firmness especially are required, and neither in the case of disease nor injury is the mischief likely to be limited. Compared with excision, Syme's amputation involves very much less risk and may be relied upon for an excellent practical result.

It may be performed either by two lateral incisions, or an anterior transverse one.

In the former (1) an incision is made on the outer side of the foot over the peronæi tendons, from two inches above the external malleolus to within an inch of the base of the fifth metatarsal bone. The skin and the periosteum are raised from off the bone, the tendons drawn to one side, the fibula divided at the upper angle, and the lower end drawn out from above and removed, dividing the external lateral ligament. The foot is then turned over and (2) an incision similar in length and direction made along the posterior margin of the internal malleolus, the tendons and periosteum being treated in the same way. The lower end of the tibia is then forced into the wound by everting the foot, and removed with a narrow saw; the upper surface of the astragalus is treated in the same way; the whole of the gelatinous tissue scraped out, and the wound thoroughly washed out and drained. If the astragalus is much involved it is better to scoop it out of its periosteal shell altogether.

The anterior transverse incision is more simple. A cut is made across the front of the joint, beginning at the tip of one malleolus, dividing all the tendons, the anterior tibial vessels and the nerve, and ending at the corresponding point on the opposite side. The ligaments are then divided as far as may be necessary, the under surfaces of the tibia and the upper of the astragalus successively exposed and removed; all carious bone gouged away with the granulation tissue, and then the tendons and the nerve sutured together again. The skin wound should unite by the first intention. An outside angular splint with the knee well bent is the best appliance, until the seat of injury is partially consolidated and the discharge reduced in amount; and after that a plaster or paraffin bandage, strengthened if necessary by slips of tin.

CHAPTER VII

INJURIES AND DISEASES OF THE HEAD

SECTION I.—MALFORMATIONS

ENCEPHALOCELE AND MENINGOCELE

AN encephalocele is a congenital tumour caused by the abnormal expansion of some part of the cerebral vesicles, so that the brain substance protrudes between the bones of the skull and prevents their proper development. In a meningocele the protrusion consists of dura mater and arachnoid only, but this is very much more rare. When in addition to the brain substance there is a great collection of fluid, causing immense distension of the ventricle, it is known as hydrencephalocele.

An encephalocele can only develop at those parts of the skull which normally contain processes of the ventricles; immediately over the nose, that is to say, corresponding to the anterior cornua (the exactly median situation is due to secondary growth of the bones); behind the mastoid process, where the lateral cornua come down; and in the neck and occipital region over the fourth ventricle. A few cases are recorded of a similar prolongation of the third ventricle into the pharynx, through the sphenoid, or between it and the ethmoid. Encephalocele has nothing to do with the fontanelles.

The occipital is the most common, the portion of the occipital bone between the inion and the foramen magnum being deficient. The frontal comes next; the others are very rare. Many cases of supposed meningocele, especially in the occipital region, are in all probability encephaloceles in which the brain substance has either atrophied or has never been developed. Hydrencephalocele explains itself.

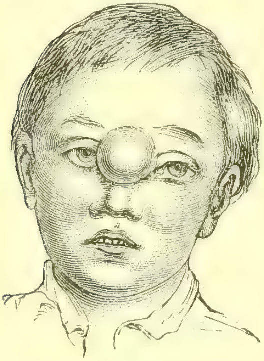


FIG. 266.—Meningocele at root of nose.

An encephalocele forms a roundish, sessile or pedunculated tumour, of very variable size (sometimes a mere nodule, sometimes larger than the rest of the child's head) projecting from the surface of the cranium. The skin covering it is generally normal, but it may be excoriated; and, when the distension has taken place very early in life, so that the development of the dorsal mesoblastic plates has been checked, it may consist merely of the undifferentiated brain-tissue and meninges, covered over with epidermis, as in some analogous cases of spina bifida. It swells up and becomes tense when the child cries, and usually admits of partial reduction on pressure, although this may cause convulsions and other cerebral symptoms. Occasionally the outline of the opening in the cranial bones can be felt distinctly.

An encephalocele is usually opaque, with indistinct fluctuation, and is only partially reducible; and it pulsates distinctly. A true meningocele is always small, and as a rule pedunculated: its contents admit of complete reduction, and if it is large enough it is perfectly translucent. Hydrencephalocele is always very large and usually pendulous, the rest of the child's head being ill-developed.

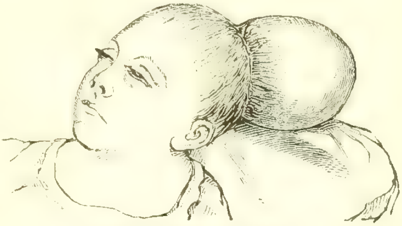


Fig. 267.—Encephalocele.

In some instances, particularly when the tumour is situated over the glabella and the skin covering it is red and vascular, great care is required to distinguish it from a nævus. They are both congenital and reducible; they both swell up when the child cries; the colour is the same; and if the intracranial tumour is a small one, reduction of its contents need not be followed by any cerebral symptoms; and it need not exhibit any arterial pulsation. I have known the diagnosis left undecided by surgeons who were certainly capable of discriminating, if any were.

Prognosis.—If the protrusion is small and the skin covering it healthy, it may not interfere with life; and in a few rare cases it has happened that as growth proceeded the neck of the tumour has become more and more constricted until at length it ceased to have any connection with the interior of the skull. Large ones as a rule continue to increase until they rupture.

Treatment.—The growth should be carefully protected from injury and not otherwise interfered with except under one condition—that it is on the point of rupture. Repeated tappings and injections of Morton's fluid have succeeded in cases of meningocele, as in spina bifida; but, except in those instances in which from the small size or pedunculated character of the tumour there is some prospect of natural cure, the probability of a good result is very remote.

Section II.—Injuries of the Head

THESE include injuries of the scalp, of the bones, and of the brain.

The scalp may be bruised or cut; there may be hæmorrhage, either exernally or into the tissues; the pericranium may be stripped off, the bone ruised or fractured; blood extravasated between it and the dura mater, r between the membranes of the brain; and the brain itself contused r torn. No wound or blow, however slight, should be neglected; even hen the superficial structures have escaped unhurt there may be serious jury to the much more important ones beneath. Afterwards inflammation ay set in, even though there is no external wound. If this occurs it may ttack the scalp or the loose cellular tissue beneath; it may begin in the one, causing osteophlebitis and necrosis, and ending either in general yæmia or in thrombosis of the sinuses, inflammation of the membranes or rebral abscess, according to the method of its extension; and finally it may art in the brain itself.

INJURIES OF THE SCALP

The scalp presents certain anatomical features of considerable surgical importance. The skin in the first place is so closely bound down to the aponeurosis beneath, that merely cutaneous wounds never gape, and superficial inflammation is never attended by much swelling or redness. For the same reason contusions often cause what apparently are incised wounds. Further, the chief vessels lie between the aponeurosis and the skin, and are embedded in such dense tissue that when they are cut they cannot retract, and can hardly be tied. On the other hand, beneath the aponeurosis the tissue is so loose that blood or pus can collect until the skin floats as on a water-bed, bounded by the zygoma, the eyebrows and the superior curved line; and the scalp can be stripped off and hang down in flaps. Sloughing, however, owing to the position of the vessels, is rarely caused in this way. Finally, the pericranium is easily separated from the bone, except at the sutures; it only supplies the outer table, not the diploe or the inner, so that when necrosis occurs from this cause the sequestrum is usually superficial. It is peculiar also that it hardly ever produces any new bone to repair an injury.

Contusions of the Scalp

The blood may be extravasted (1) in the scalp itself; (2) in the subaponeurotic layer; or (3) between the pericranium and the bone.

The first, owing to the denseness of the tissue, is always insignificant. The second may be either diffuse, and of enormous extent, or circumscribed, and then very often it is curiously deceptive. The blood around the margin coagulates into a hard dense ring, the inner edge of which is sharp and well-defined, while the outer is bevelled off; in the centre it remains fluid, so that when the finger is pressed upon it the margin stands out as clearly as the edge of a depressed fracture, for which it may easily be mistaken. The ring, however, is distinctly raised above the level of the surrounding bone, and it can always be indented. I have known the opposite mistake made. Abscesses sometimes give rise to the same kind of impression, and it must be remembered that the presence of a hæmatoma does not exclude the existence of a fracture.

The third (cephalhæmatoma) only occurs in infants and nearly always from injuries received at birth. It is most common on the parietal bone, though I have seen it on the occipital, and it is easily recognised by the way in which it is limited to one bone; it never extends over the sutures. Like the former, the margin becomes hard, and a certain amount of organisation, and even ossification, takes place; the centre remains fluid, and for a long time gives rise to a sensation of parchment crackling when pressed upon.

Absorption in all these cases is slow, but, unless inflammation sets in, they should never be incised; and aspiration is rarely necessary. The cephalhæmatoma of infants should never be touched; in other cases lead lotion may be applied at first, or, if the patient will lie down, an ice-bag, to check the extravasation and hyperæmia; afterwards well-applied pressure is the most efficient remedy.

Wounds of the Scalp

These, like contusions, may be superficial, involving the skin only; or extend into the subaponeurotic layer; or lay the bone bare. The first are rarely of any extent; in the second, if the hair is entangled in machinery, or the head caught under a cart-wheel, the whole scalp may be detached and hang down in a flap, but it rarely sloughs; in the third there is an additional danger, for the bone is exposed, and is often bruised or scratched. Hæmorrhage from the torn vessels is often abundant, but neither ligature nor torsion is of any use. Pressure stops it at once. Acupressure may be used, but a bandage is nearly always sufficient; care, however, is necessary, as it may be applied so tightly as to cause a slough.

Treatment.—Scalp wounds require no special treatment, the same principles must be followed as elsewhere; the only peculiarities are the extraordinary vitality of the skin, and the ease with which inflammation, if it once sets in, spreads in all directions. Therefore no portion of scalp should ever be sacrificed, no matter how bruised or dirty it is; and perfect cleanliness and perfect drainage must be insisted on. If this is carried out, they may be treated like other wounds and with exceptional success.

The head must be shaved around the injury, the wound carefully explored and washed out thoroughly with an antiseptic, all oozing stopped, and any bagging or collecting of fluid prevented. Counter-openings may be made and drainage-tubes inserted, if there is a dependent pouch; but in most cases it is sufficient to support the skin well against the skull so as to keep it at rest and ensure early adhesion. Then the edges of the wound may be dusted over with iodoform and covered with an absorbent dressing, such as wood-wool, or a sponge wrung out of carbolic. There is no objection to the use of sutures, if care is taken; but of course, if the wound is tightly sewn up, and suppuration allowed to take place beneath, serious consequences must ensue. Even if half the scalp is stripped off and hangs down the back of the neck, or over the face, it may be treated in this way, and often will adhere at once. If it does not, the under surface throws out granulations, and union takes place by the third intention. In all cases of severe injury the patient should be confined to bed, and kept perfectly quiet, on low diet; and care must be taken that the bowels do not become confined. It must never be forgotten that, in addition to the scalp wound, there may be very great injury to the brain.

So long as there is no pain or fever, the wound should be left alone. If, however, one spot is tender, or if the temperature rises, or if there is any shivering, it must be exposed at once and carefully examined: it nearly always means that some of the secretion is pent up. As a rule it is sufficient to introduce a probe, or to loosen a suture: a drop or two of fluid escapes, and the symptoms are relieved at once.

Erysipelas sometimes attacks scalp wounds, but they are not more liable to it than others that are equally exposed. The danger is that the superficial wound may close, and the discharge collect and decompose beneath. The cellular tissue is so loose that suppuration soon spreads all over the head; the scalp becomes boggy and œdematous; the eyelids are swollen and the forehead reddened; the pulse becomes quick and feeble; the temperature rises; delirium sets in; and the condition becomes one of extreme gravity. If left to itself the whole of the cellular tissue may slough, leaving the bone absolutely bare; or the patient may sink from exhaustion or septic poisoning (especially as this is likely to occur in those whose health is broken down), or the inflammation may spread along the emissary veins into the diploe and sinuses of the cranium, and set up thrombosis and pyæmia. In such a case the wound must be laid open at once, only such sutures being left as are absolutely necessary to prevent a flap hanging down; small incisions, parallel to the main arteries and going right down to the bone, made wherever the skin is boggy; and warm boracic fomentations applied, to encourage the discharge as much as possible. Quinine and carbonate of ammonia are nearly always required; it is very seldom that any food can be taken; and in many cases the condition of the pulse is such that stimulants must be given freely.

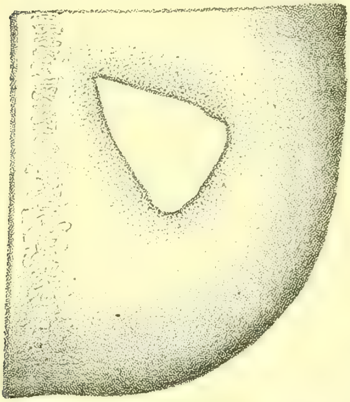


FIG. 268.—Exfoliation of a triangular plate of bone from the vault of a skull, caused by denudation. Three weeks after the injury.

When the pericranium is detached the risk is greatly increased. Necrosis of the outer table may occur simply from its blood-supply being cut off; more frequently it becomes vascular and throws out granulations, minute red dots making their appearance on the bare white bone, and projecting more and more as the compact tissue becomes absorbed, until they form a perfectly uniform layer. Or worse than this may happen: inflammation may set in. If this occurs, the whole thickness of the bone is almost sure to perish, and the mischief may extend to the membranes of the brain, or into the venous sinuses, and cause either diffuse meningitis or general constitutional infection. Every case of scalp wound in which the bone is exposed requires to be watched with the greatest care.

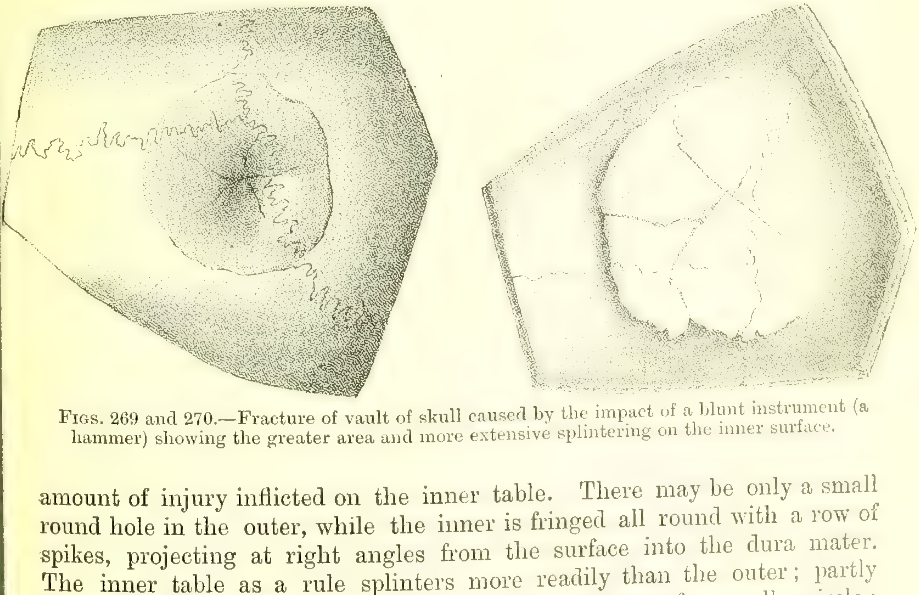
FRACTURES OF THE SKULL

These are divided into fractures of the vault and fractures of the base. They are nearly always the result of direct violence. If the area on which the blow falls is limited, the injury is limited too; and naturally this is more common on the vault. If, on the other hand, the force is diffused over a wider area, the cranium is compressed, the most inelastic and unyielding part gives way, and a fissure is produced which generally runs across the base and part of the vault as well. The distinction therefore is not perfect, but it is found to work conveniently.

1. *Fracture of the Vault*

Owing to its arched shape, its elasticity even in adults, and the presence of sutures breaking up and softening the force of blows, this escapes more frequently than might be expected. In infants it is sometimes bent in like a piece of tin, without any actual tearing, but in many of these cases the inner table gives way, as in greenstick fracture.

The fracture may take the form of a simple fissure; or it may be stellate or comminuted. Occasionally the outer table only is hurt; and a few rare cases are recorded in which this has escaped, and the inner only has given way; but nearly always it extends through the whole thickness. If the bone is driven in, the fracture is said to be depressed; in most instances the whole substance is forced in, but over the frontal sinuses, and in contusions, the inner table may not be affected; generally it is splintered a great deal more than the outer. It is called a gutter fracture if the depression is long and narrow; a pond fracture if it is circular. In children, owing to the elasticity of the bones, depression may take place without fracture, especially if the area is extensive; but probably in many of these there is really some tearing of the inner layer. Elevated fractures, caused by oblique cuts, are rare in civil life, and can only occur while the bones are still capable of yielding. Punctured fractures, which are produced by the impact of some sharp body, such as a nail, are particularly serious owing to the amount of injury inflicted on the inner table. There may be only a small round hole in the outer, while the inner is fringed all round with a row of spikes, projecting at right angles from the surface into the dura mater. The inner table as a rule splinters more readily than the outer; partly because it is thinner and more brittle, and forms part of a smaller circle; but mainly because, in all ordinary accidents, the blow falls upon the outer first, so that the force in travelling through the diploe becomes distributed over a wider area (figs. 269 and 270). If a bullet passes through the cranium from within outwards the reverse is the case.



Figs. 269 and 270.—Fracture of vault of skull caused by the impact of a blunt instrument (a hammer) showing the greater area and more extensive splintering on the inner surface.

(*a*) *Simple Fractures*

Of themselves, simple fractures of the vault are of little or no consequence; contusions, fissures, and fractures without displacement do not admit of proof; and even when the bone is comminuted and the depression considerable, the diagnosis is often only a conjecture, owing to the amount of blood extravasated. Their gravity arises from the fact that serious injury to important structures is so often associated with them. Concussion or contusion of the brain; hæmorrhage between the membranes, or, especially if the course of the fissure traverses the middle meningeal artery, between the dura mater and the bone; rupture of the venous sinuses and laceration of the membranes are of frequent occurrence after simple fractures; more rarely the contents of the cranium (the cerebrospinal fluid at least) find their way out, and form a soft fluctuating and pulsating swelling underneath the aponeurosis—cephalhydrocele.

Later, especially in cases in which the bone is severely contused, inflammation may set in, though it is very rare in comparison with compound fractures. It may be either acute or chronic. In the former case the whole thickness of the bone perishes; lymph is poured out beneath the pericranium; the scalp becomes boggy and œdematous (Pott's puffy tumour); and suppuration follows and spreads to the inner surface of the cranium. A few cases are on record in which the abscess resulting from this has been merely local, between the bone and the dura mater; much more frequently the inflammation rapidly involves the venous sinuses, and ends in either diffuse suppurative meningitis or pyæmia.

Chronic inflammation is even more uncommon, but an extraordinary thickening of the bone is said to have occurred after simple fracture. The whole skull may be affected; or irregular nodules may grow out and cause constant wearing pain and neuralgia. Loss of power, partial paralysis, and even insanity and epilepsy have been known to follow.

(*b*) *Compound Fractures*

In the majority of instances the nature of the injury can be seen at once. There is a fissure, appearing as a thin red line, out of which blood continues to ooze, contrasting with the white bone around; or the bone is plainly comminuted and driven in; or the broken edge of a knife or other foreign body can be seen upon the surface. But this is not enough; the wound must be carefully and thoroughly explored with the finger, the mere diagnosis is not sufficient; its extent and the depth and character of the displacement must be made out as accurately as possible, especially in the case of punctured wounds. There are many sources of fallacy: a suture can easily be mistaken for a fracture, or the edge of the pericranium, if it is cut and one side is adherent to the bone, may feel like a fissure, especially if a probe is used. The temporal aponeurosis has before now given rise to difficulty: a foreign body may be broken off flush with the surface, so that it can scarcely be detected; or, as in the case of the frontal sinuses in men, though the outward depression is very considerable, the inner table may not be injured at all.

Serious complications are much more common in compound fractures. In the first place the force is often greater, and nearly always is concentrated on one small spot, so that the inner table is driven inwards and extensively splintered. The more nearly a fracture approaches the punctured form, the more dangerous it becomes; it does not matter so much if the depression is wide and extensive, or if, owing to the softness and elasticity of the bones, there is little or no splintering; the dura mater is not injured, and symptoms of compression, merely from displaced bone, are exceedingly rare; but where the inner opening is fringed with a circle of little spikes, projecting vertically inwards, and tearing and irritating the membranes and the brain, inflammation is almost certain (fig. 271). In addition compound fractures are always exposed to the risk of decomposition. Blood is extravasated into the diploe, and between the dura mater and the bone; the fracture is often comminuted; there are numerous little spaces and fissures between the fragments which cannot drain, and the wound is frequently filled with dirt and other foreign substances. Under these circumstances, unless steps are taken to prevent it, inflammation must break out, and though fortunately it often remains limited to the wound, and merely causes necrosis of the broken fragments, it may at any moment spread into the surrounding bone, or, especially if the dura mater has been pricked, into the membranes of the brain and set up fatal meningitis.

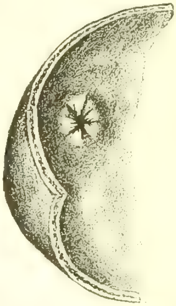


Fig. 271.—Punctured fracture of skull.

Treatment.—(*a*) *In simple fractures.*— So far as the bone itself is concerned, injury to the vault of the skull rarely requires anything. Unless there are definite symptoms of compression, either growing worse or refusing to clear up, nothing should be done. But it is so often associated with concussion and contusion of the brain, and the extent of injury is so entirely unknown, that in any case in which there is the least ground for suspicion the utmost precautions must be taken. The patient must be placed in a darkened room with the head shaved, and an ice-bag, or better, Leiter's coil applied; every source of irritation or excitement should be excluded, the bowels should be opened, preferably with a calomel purge, and nothing but the simplest diet allowed. Rest in bed must be strictly enforced for at least three weeks, and the patient must be carefully watched for months. The great fear during the first few days is that hyperæmia and inflammation of the brain may occur; after that the chief risk comes from the bone, which may inflame and cause necrosis, meningitis, or pyæmia; later still, even years after, symptoms of cerebral irritation may make their appearance, sometimes merely undue excitability, or fits of temper, especially if there is any indiscretion in diet or abuse of stimulants; occasionally, but fortunately very rarely, more serious trouble, such as epilepsy and even insanity.

(*b*) *In compound fractures* the wound in the soft parts and the injury to the bone require something further. The former should be treated as already described: the hair should be shaved off, the scalp well washed, the hæmorrhage stopped, foreign matter and dirt carefully removed, and then all the part that has been exposed thoroughly washed out with corrosive sublimate or some other antiseptic. It should then be well dried, the edges dusted over with iodoform and brought together with sutures (catgut is especially useful where there is no tension), leaving suitable openings for the escape of the lymph, and if necessary one or two tubes may be inserted. Then it should be carefully covered over with a thick layer of some dressing sufficiently absorbent to soak up any discharge at once, and bandaged to avoid displacement and secure rest.

Simple linear fissures, not depressed and not caused by the impact of a sharp weapon, may be covered in at once, the pericranium being replaced if it is torn off. There is no splintering in such a case, no fear of spicules irritating the dura mater and the brain, and the sooner the fracture is converted into a simple one the less the risk of decomposition and suppuration. *Punctured fractures*, on the other hand, should always be trephined, the wound in the outer table being included in the circle of the instrument. It is impossible to ascertain the condition of the inner table; in nearly every case it is starred and the splinters driven inwards; the operation adds nothing to the gravity of the case, and deep punctured wounds passing through strata of different consistence cannot either be cleaned or drained.

In compound depressed fractures, portions of bone that are detached or loose or driven into the substance of the dura mater, must be carefully picked out. If there are symptoms of compression, or if the size and depth of the wound make it probable that the inner table is splintered, the bone must be elevated, and, if necessary, part of a circle removed with the trephine, the pin resting on the uninjured margin. No pains must be spared to make the elevation effectual, and to exclude the possibility of splinters being left under the overhanging edges. It is true that a large proportion of patients never suffer in any way; that fragments of bone and even foreign bodies have remained embedded in the substance of the brain itself for years, without its being known; but they are never safe. So many cases are recorded of disturbances of the most varied character—motor, sensory, and psychic—being caused by the presence of a depressed fracture, and being cured by its elevation, that unless the depression is smooth and even, as it nearly always is in children (fractures of the skull in them rarely require much interference), it is better to raise it at once. The operation does not increase the patient's risk; trephining, when done as a precaution and not as a last resource for a disease that has almost proved fatal already, is very rarely followed by any ill result; and in many cases in which the wound, filled with extravasated blood, has been exposed to the air, and perhaps ground in with dirt, the cleansing process cannot be thoroughly carried out, or the risk of decomposition and inflammation avoided, without its being done.

Sometimes it is merely necessary to introduce the point of an elevator under one of the edges of a depressed fragment, and gradually lever it up until it is on a level with the rest. Very often, however, the fragments are so locked together that this cannot be done without first removing a portion of bone; or it is found that the injury is much more extensive than it appeared to be at first sight, and that the splintering extends a long way under the edge of the outer table. Then it becomes necessary either to remove some of the overhanging edge with Hofmann's gouge-forceps or to apply the trephine on the margin. In any case great care must be taken to preserve the pericranium and to avoid detaching any adherent fragments. The wound must be dressed in the ordinary way. The portion of bone that has been removed may be replaced, and in some cases it retains sufficient vitality to form fresh adhesions; more often it gradually becomes absorbed, or, if suppuration sets in, perishes and is thrown off as a foreign body. It very rarely happens that there is any reproduction of bone; the edges of the opening become rounded and smooth, and a dense fibrous cicatrix forms upon the surface of the dura mater, strong enough of itself to act as a protection to the brain, unless the opening is very large.

2. *Fracture of the Base*

Fracture of the base of the skull is sometimes the result of direct violence —when, for example, a revolver is discharged into the mouth, or a stick is forced through the roof of the orbit, or the condyle of the jaw is driven through the glenoid fossa. More often it is caused by a fissure extending from the vault. The fracture starts from the point that is struck, and generally passes across the base of the corresponding fossa, sometimes when the force is great involving more than one. The middle suffers the most frequently, as might have been expected, and a very common course for the fissure to take is across the petrous portion of the temporal bone and the internal auditory meatus. Occasionally it is produced in other ways. The skull, for example, may be driven down on to the vertebral column just as a hammer-head is forced on to the shaft, with such violence as to break the bone round the foramen magnum; or, as in falls upon the head, the vertebral column may be driven against the skull. In fracture by *contre-coup* the injury is on the opposite side of the head, at the other end of the diameter. The orbital plate of the frontal bone, for example, is sometimes fissured from a fall upon the occipital region. The skull is suddenly

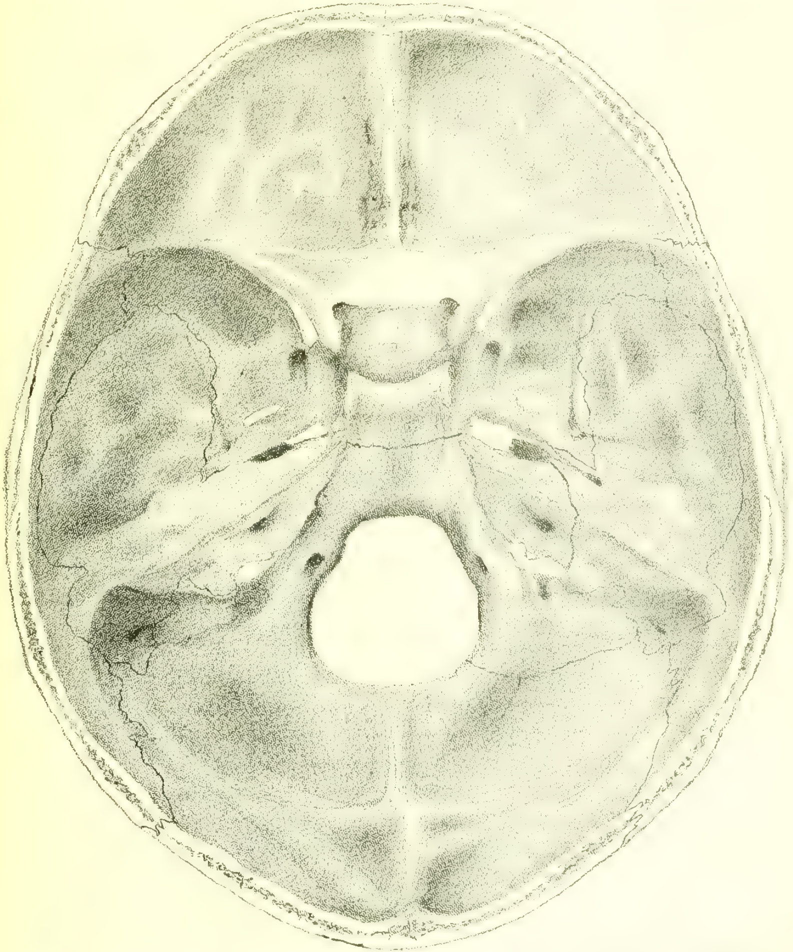


FIG. 272.—Base of skull, showing the most frequent lines of fracture (*a*) across the petrous portion of the temporal bone, cutting the internal auditory meatus in two, (*b*) passing between the foramina media, and (*c*) radiating from the foramen magnum into the thin bone of the occipital fossa.

shortened in its antero-posterior diameter, and correspondingly widened in its lateral and vertical ones; both the frontal and the occipital regions are flattened out; but the former, being the thinner, more brittle and less regular in its elasticity, gives way first. It must not be forgotten that fractures extending into the ear, nose, and pharynx are really compound.

The diagnosis of fracture of the base of the skull can only be made either from an escape of some of the contents of the cranium, or from injury to some of the structures that pass out through it. It may be suspected whenever there is evidence of serious injury to the brain after a severe blow upon the head, but it can only be proved by one of these. Probably it is present in many of the cases of severe contusion to the brain, in which the patient, after lying in a state of semi-unconsciousness for days and even weeks, slowly recovers. If it is compound, it adds very distinctly to the danger of the case.

The brain substance itself rarely escapes, except in gunshot injuries and compound fractures through the ethmoid, when, for example, there is a violent blow at the root of the nose breaking up the cribriform plate and lacerating the dura mater. The ordinary signs that are looked for are the escape of cerebro-spinal fluid and hæmorrhage.

Escape of cerebro-spinal fluid.—This may take place, as already mentioned, on the vertex, coming from the ventricles of the brain, and forming, if the fracture is a simple one, a soft fluctuating and pulsating swelling, which causes symptoms of compression when it is reduced; or it may escape from the ear, the nose, or the roof of the pharynx. Owing to the frequency with which fractures of the middle fossa of the skull pass across the internal auditory meatus and tear open the prolongation of the arachnoid along the auditory nerve, the ear is by far the most common of the three. If the tympanic membrane is torn across, it pours out from the external meatus; if it is not, it trickles down the Eustachian tube into the pharynx and probably escapes notice altogether. In the case of the nose and pharynx it must come from the great sub-arachnoid sac at the base of the brain, possibly along the course of the olfactory nerves. In one or two instances the fissure in the petrous portion of the temporal bone has been so fine that it could only be detected after maceration.

The nature of the fluid may be recognised partly by its quantity, partly by its chemical composition. The escape of a teaspoonful of moderately clear fluid from the ear, a day or two after a severe blow on the head, cannot be regarded as proof of fracture of the base of the skull. If the tympanic membrane is torn across, there is often, especially in men, a certain amount of secretion of a watery fluid from the mucous membrane lining the mastoid cells; but this does not come on immediately after the accident, and, like catarrhal secretion generally, is always more or less turbid. It is possible the same thing may occur in connection with the frontal sinuses. Cerebro-spinal fluid begins to escape either at once or immediately after the hæmorrhage has ceased, and as much as a pint may flow out in twenty-four hours. Usually it continues for several days and then ceases of itself. That it comes from the interior of the cranium may be shown by making the patient blow his nose hard, compressing it at the same time: the intra-cranial pressure rises rapidly and the fluid pours out; but the experiment is not advisable. Its chemical composition agrees perfectly with that of cerebro-spinal fluid: there is an appreciable amount of chloride of sodium present; a trace of sugar can sometimes be found; but the amount of albumin is much too small to give any reaction with nitric acid, or acetic acid and ferrocyanide of potassium, even when the fluid has been concentrated at a low temperature.

Hæmorrhage naturally is more ambiguous. The mere escape of blood after a severe injury to the head cannot be regarded as a diagnostic sign of any value, unless there are special features in connection with it. Every case of hæmorrhage from the ear, for example, must be looked upon with grave suspicion, unless it can be traced to some small laceration; but it can only be regarded as proof of fracture when it is immediate, copious, and long continued. The same thing may be said of hæmorrhage into the tissue of the orbit. If the stain does not make its appearance under the conjunctiva for some time after the accident, and if it gradually creeps forwards towards the cornea (not as in an ordinary black eye, from direct injury, diminishing as it recedes), it is proof that the hæmorrhage comes from behind, possibly from fracture of the orbital plate of the frontal bone; and if it slowly soaks forward into the eyelids, the lower first, until they are both jet-black, without any staining of the cheek or forehead around, or if the eyeball is protruded, it becomes much more definite. But it is only certain when the nature of the accident is such as to preclude the possibility of any direct injury to the structures in the orbit itself. Under such conditions, serious hæmorrhage coming from behind can only arise from a fissure traversing the orbital plate of the frontal bone, or part of the sphenoid, and opening up perhaps the anterior extremity of the cavernous sinus.

Hæmorrhage into the nose or mouth, or into the tissues at the back of the neck, and vomiting of blood after any severe injury to the head, in the same way must be regarded as very suspicious, and any case in which they occur must be given the benefit of the doubt, and treated as if it were certain that there was a fracture of the base; but they cannot be regarded as proof, unless the presence of all other injuries can be excluded.

The cranial nerves may be injured in fractures of the base of the skull: either torn, when the effect is immediate and usually permanent, or merely compressed by blood extravasated into the sheath or into one of the bony canals. Sometimes this is followed by neuritis, coming on after an interval of two or three weeks, and gradually disappearing again. The seventh nerve suffers the most frequently, causing deviation of the soft palate, as well as facial paralysis; but atrophy of the optic disc, from rupture of the optic nerve, has been found after fractures of the anterior fossa, and occasionally the fifth and the motor nerves of the eye are involved.

Fractures of the base of the skull must be treated in the same way as fracture of the vault: the brain is always severely injured, and the greatest care must be taken to ward off any source of irritation. If the cribriform plate of the ethmoid is comminuted, an attempt should be made to remove the fragments, either through the orbit or the nose, for fear of the dura mater being injured, and to ensure more perfect drainage. The discharge is certain to become purulent, and is usually exceedingly offensive, especially if the injury is followed by necrosis. In the case of the ear, the meatus should be gently syringed out with an antiseptic, and then covered with a large pad of absorbent cotton, renewed as often as required. The fracture is compound, but meningitis rarely follows.

Callus is scarcely ever thrown out, the parts lie absolutely quiet, and there is no irritation; in many cases union is by fibrous tissue only; and the edges of the fracture become smoothed down and absorbed to some extent, so that the fissure, when the skull is macerated, appears much larger than it really was.

INJURIES OF THE BRAIN

The brain may be injured by concussion, contusion, or compression: blood may be extravasated between the membranes or in the substance of the brain itself, and the cranial nerves may be torn or crushed at their origin. The symptoms and diagnosis of these affections must be considered separately. The treatment may be dealt with as a whole.

Concussion

Concussion is the effect produced by a blow upon the head sufficiently severe to affect the functions of the brain without causing any considerable alteration in its structure. There may be merely a temporary sensation of giddiness; or the patient may lie for hours in a state of semi-unconsciousness; or, rarely, the depression may prove fatal, without reaction ever setting in.

Opportunities for examining the condition of the brain are so rare that very little is known about the pathology of concussion. Minute ecchymoses and small points of contusion are found in the majority of instances; but, as the symptoms subside long before these disappear, they can scarcely be regarded as the cause. A certain amount of congestion is nearly always present, arising from paralysis of the walls of the vessels; and in all probability this is the immediate source of the functional depression. The rapidity with which recovery takes place as soon as reaction sets in, and the peculiar irritability that follows, point distinctly to some altered condition of the circulation. It has been shown experimentally that violent vibration, or even a slight degree, provided it is long continued, is capable of suspending more or less completely the activity of nerve-cells. If the cortex only is affected, the depression is merely transient and the symptoms soon disappear; but if, in addition to this, the ganglia at the base of the brain are involved, particularly the vaso-motor and the cardiac centres, the effect is more general and more lasting. The walls of the vessels everywhere, those of the cortex included, are relaxed; the blood-pressure falls; the blood lies stagnant in the great veins of the abdomen; the surface becomes cold and white; the temperature of the skin is lowered; and the pulse is rapid and feeble. In short, all the symptoms of severe shock are present, with the cerebral ones strongly accentuated.

Symptoms.—In the slighter cases there is merely a little transient giddiness or confusion; when the injury is severe, the symptoms may be divided into four stages—collapse, rallying, reaction, and convalescence.

The first is characterised by depression, general and extreme, beginning at once and sometimes proving fatal, as the action of the heart becomes more and more feeble. The patient lies without moving, but the attitude is not that of utter helplessness; consciousness is not lost, though no notice is taken of anything; he can easily be roused so as to speak, and move his limbs, but only for a moment; the skin is cold, pale, and clammy; the temperature low; the pulse feeble and rapid, sometimes intermittent, or so faint that it can scarcely be felt; the respiration shallow, with occasional sighing; the eyes glassy and devoid of expression; the pupils either contracted or dilated; the sphincters relaxed, and reflex excitability almost abolished. Then, after an interval that varies from a few minutes to several hours the second stage begins: the heart begins to recover; the cardiac and vaso-motor centres regain their power; the pulse becomes fuller and stronger; the surface grows warmer; the brain is better supplied with blood; and sensibility rapidly returns. Very often at the same time there is vomiting, partly due to the fact that digestion has been interrupted, partly to the recovery of the pneumogastric centre; and the reaction is assisted by the compression of the abdominal veins driving the blood into the circulation.

The third stage, that of reaction, is scarcely noticeable in slight cases, especially in children; there is merely a little restlessness or irritability, often put down to temper. In the more severe ones, however, after twenty-four or forty-eight hours the symptoms change their character completely. The circulation becomes quickened, the amount of blood that flows through the brain is immensely increased; the head begins to ache and throb; the carotids beat so that they can be seen; the face is flushed; the skin becomes hot and dry; the eyes cannot face the light; there are noises in the ears; sometimes there is extreme drowsiness, so that the patient lies for hours in a semi-torpid condition, curled up in bed away from the light; sometimes there is great irritability or even wandering. In short, there are all the symptoms of hyperæmia of the brain, such as are met with in the early days of inflammation.

Gradually, in the course of a few hours, this begins to subside and convalescence sets in; very rarely, considering how common concussion is, it runs on to inflammation, but it is often months before the cerebral circulation is thoroughly under control and is able again to regulate itself; for a long time it continues unduly excitable, responding to the slightest stimulus with disproportionate energy. The memory is defective: often, curiously enough, the accident itself and the events of a few hours before are completely forgotten; the patient is liable to unreasonable outbreaks of temper; headache and slight attacks of giddiness are not uncommon; there is a peculiar susceptibility to the effects of alcohol, and any little mental emotion or anxiety causes an excessive amount of disturbance. Sometimes this condition persists for the rest of life; the patient loses his aptitude for business work, and is said by his friends never to have been himself again.

Contusion of the Brain

This may or may not be attended by concussion, according to the extent of surface that receives the injury and the amount of general shock, and it may either cause a definite train of symptoms of its own, or it may be so confused with concussion, compression or hyperæmia as to be almost unrecognisable.

Laceration of the brain may occur without any wound of the soft parts or fracture of the bone; probably it is present in all cases of severe injury to the head—certainly if there is a fracture; and it is produced either by the sudden alteration in shape when a violent blow falls upon the skull; or by fragments of bone or foreign bodies that are driven in. In the latter case the dura mater is torn; there may be hæmorrhage from the meningeal arteries, and the injury may be compound. The brain is bruised either immediately under the seat of injury, or exactly at the opposite side, at the other end of the diameter; the sudden arrest of the momentum when the head strikes the ground dashes it against the opposite side of the skull, and, especially if the surface is uneven or irregular, bruises it against the bone. If the force is at all severe, it is hurt in both places. This injury by *contre-coup* (as it is called) may occur at any point, but is met with most frequently at the apex of the temporo-sphenoidal lobe, or on the under surface of the frontal, partly because of the frequency of falls upon the occiput. Multiple ecchymoses, arising from the rupture of small vessels, deep in the substance of the brain, and even in the floor of the fourth ventricle, are often found in post mortem examinations of fatal cases, in addition to the superficial injuries. It is possible that they are often present, but, unless they involve some part the function of which is definite and known, there is no means of making a diagnosis.

The extent of injury may vary from a mere superficial bruise, with a few points of extravasation on the surface or in the substance of the grey matter, to complete disintegration. When it is severe, the hæmorrhage may plough up the cortex in all directions, extending deep into the white substance and spreading in the subarachnoid space over the greater portion of one hemisphere. It very rarely breaks into the ventricles, but it not unfrequently extends into the subdural space as well as into the subarachnoid. The subsequent changes are the same as those that occur elsewhere: as soon as the hæmorrhage ceases the vessels round the seat of injury begin to dilate, the circulation becomes more rapid, lymph pours out, infiltrating the clot and the structures around, so that the pia mater becomes thick and milky, and all the neighbouring brain substance becomes so soft that it can be washed away by a stream of water. Then, if the part injured is not a vital one, if the hæmorrhage is not sufficient to cause compression, and if there is no further cause of irritation, no bone-spicules driven in, and no septic decomposition, the blood-clot slowly breaks down, the hæmoglobin soaks into and stains the tissues around, the fibrin and corpuscles are absorbed, the torn and lacerated brain substance undergoes fatty degeneration, the damaged portions are removed or repaired, and gradually the injured space becomes filled with lymph, which organises and forms a depressed cicatrix, firmly adherent to the membranes, and discoloured from deposits of hæmatoidin. Blood extravasated into the subarachnoid space is usually absorbed; when there is an extensive collection in the subdural it may become organised and form a tough brownish-coloured membrane on the under surface of the dura mater; or it may lose its colour completely and gradually become converted into a thin-walled transparent cyst, generally adherent either to the dura mater or the arachnoid, but sometimes quite free, resting in a depression on the surface of the cortex.

The termination, however, is not always so fortunate; in many cases the amount of blood poured out is so great as to cause compression of the brain, and death ensues in the course of a few hours from coma and paralysis; or the hyperæmia and tension continue to increase until, after the lapse of two or three days, inflammation sets in. This may happen even when there is no external wound; but in compound fractures, when spicules of bone are driven into the dura mater, there is everything to favour it. An injury of this kind is always the result of direct violence; everything is bruised; the deeper parts suffer in particular, owing to their delicate structure; the wound is of such a shape and depth that it can rarely be drained effectually; it is filled with broken-down blood-clot ready to decompose at once, and is often covered with dirt and foreign matter. At a later period, after months or even years, when these dangers are long since past, others are sometimes met with. Occasionally the softening and degeneration of the brain in the immediate neighbourhood of the injury spread to the parts around, so that large areas are destroyed; or chronic inflammation sets in and an abscess forms in the substance of the brain; or the cortex becomes atrophied from pressure, and sclerosed tracts make their appearance in the anterior and lateral columns of the cord.

Symptoms.—The symptoms of contusion of the brain depend upon the locality of the injury. In many cases they are entirely wanting; in all cases of concussion, for example, a certain amount of bruising is present, but unless the injury is extensive or some special centre is involved (such, for instance, as that which controls the function of speech or the movements of the arm) there is no evidence of it. The occipital, temporo-sphenoidal, and part of the frontal lobes may be very seriously injured without there being any symptoms of it, though there may be every reason to suspect it.

In other cases symptoms are present similar to those of concussion: at first there is extreme depression, the patient lies almost unconscious in a state of profound shock; then, when this passes off and the circulation through the brain begins to recover, a period of reaction sets in: the temperature rises; the face becomes flushed; the patient becomes excited and irritable; and perhaps, if the hyperæmia extends to the motor area, spasmodic contraction of groups of muscles and even general convulsions occur. But though the symptoms may be of the same class in concussion and in contusion, there is a striking difference in the length of time they last. In the former the hyperæmia is transient, and either subsides or passes on into inflammation within forty-eight hours; in the latter it may persist for weeks. In the one case there has been temporary paralysis of the walls of the vessels, and, as in a limb when Esmarch's bandage is removed, this is followed by a transient hyperæmia as soon as the circulation recovers; in the other the brain substance is crushed and torn, and, just as the skin over a severe bruise remains hot and tender until the injury is completely repaired, so there may be hyperæmia and increased excitability of the nerve-tissue for a variable distance around the bruising in the brain for a proportionate length of time.

Such cases are often met with after severe injuries to the head, as, for example, fracture of the base of the skull; and the prognosis is always very grave, for though a large proportion recover, further hæmorrhage or inflammation of the brain may occur at any time. There are the same symptoms as in the later stages of concussion, but they are much more strongly marked. The patient lies curled up in bed, with every joint flexed and his head turned away from the light; he is conscious, but pays no attention to anything; if spoken to, he does not reply; and if roused, or if an attempt is made to move him, he often becomes violent or abusive, and tosses himself restlessly from side to side until the old position is regained. The head is hot and aches violently; the face is flushed; the pupils contracted; and the temperature generally slightly above normal. In severe cases, the patient often passes everything under him, and is the source of bitter complaint on the part of the nurses; sometimes, but not often, there is retention. Then, gradually, at the end of perhaps three or four weeks, when the circulation through the brain is again becoming normal, the irritability begins to subside, the other symptoms disappear, and often the patient will declare that he has absolutely forgotten, not only all that has happened during his illness, but the accident itself and the events that immediately preceded it.

In a third class of cases there are local symptoms, either by themselves or in addition to these. The injury has affected a portion of the brain which is concerned with carrying out some special work, and the effect depends upon the degree to which the nerve-tissue suffers. If it is disorganised, the function of the part, whatever it may be, is abolished; later on it may recover, or some other portion of the brain may perform its duties, more or less well, but for the time being its action is completely lost. This, when it involves a group of muscles, is known as *monoplegia*. If, on the other hand, the injury is not so severe, if it is merely sufficient to excite and increase the irritability of the cortex without destroying it, there may be spasmodic contraction of groups of muscles (*monospasm*), or of a limb, or even general convulsions affecting the whole body. The occurrence of either of these symptoms is of the greatest significance; if they are local, and if they occur within twelve hours of an injury to the head, they point definitely to some laceration of the brain or to progressing hæmorrhage involving the cortex or the medulla.

(*a*) *Cortical lesions.*—The symptoms to which these give rise are always manifested on the opposite side of the body. It must be remembered, however, that as injury to the brain by *contre-coup* is very common, this may be on the same side as the injury to the head.

A blow upon the right side of the occiput is frequently followed (in right-handed people) by aphasia. This may be accompanied by spasm or by paralysis of the muscles of the lower part of the face on the right side; or either of these may make its appearance later, as the hæmorrhage extends. The patient, on coming round from the concussion, is entirely unable to speak; or can only make use of a limited number of words; or constantly uses wrong ones, and is conscious that he does so. The centre for speech is situated in the posterior part of the third left frontal convolution, and immediately behind it, at the lower end of the ascending frontal one, is the centre that controls the movements of the lips and mouth associated with it. In a fall upon the right side of the back part of the head this portion of the brain is dashed violently against the edge of the anterior fossa of the skull. If the bruising is severe there is complete loss of function; if slight, it is only partial; and if the bleeding continues, the effect spreads in order to the neighbouring centres, first irritating them and causing monospasm, then compressing or destroying them, so that monoplegia sets in.

Spasmodic contraction or paralysis of the upper part of the face and eyelids, after a severe blow upon the head, is due to injury of centres that lie a little higher up in the ascending frontal convolution. The lower part of the face and the platysma are affected when it extends to the ascending parietal on the same level. Brachial monospasm or monoplegia is the result of irritation or compression of the middle portion of the same two convolutions, the centre for the movements of the arm, like those for the muscles of the face, lying on both sides of the fissure of Rolando. If the stimulus continues to spread upwards (as, for instance, in hæmorrhage from the middle meningeal) the associated movements of the leg and arm become involved; and if it extends so far backwards that it reaches the superior parietal lobule, those confined to the leg alone. The muscles of the trunk appear to be under the control of centres that lie on the inner side of the hemisphere facing the falx cerebri.

1. *Cortical paralysis.*—If the bruising is severe, this is immediate; if not quite so bad it comes on gradually, some hours perhaps after the accident, and, as the hæmorrhage extends, spreads by degrees from one group of muscles to another. Often, especially if there is hæmorrhage into the subarachnoid space, the paralysis is preceded by convulsions, which may involve the same muscles, or may be general, or may even affect the opposite side of the body; the blood, as it spreads over the surface of the cortex, stimulates it first, and then compresses it, until perhaps the whole of one hemisphere is covered in. As a rule, the paralysis of simple contusion (without compression) stops short of complete hemiplegia. If it makes its first appearance after the lapse of several days, or if it continues to extend, it is a sign either that the softening is spreading, or that there is the commencement of a cerebral abscess.

2. *Cortical spasm.*—In some cases this is immediate, caused by the irritation of the laceration or by the blood as it spreads over the surface of the brain; in others it does not make its appearance for some time. If the nterval is only a few days, it is probably due to the hyperæmia that sets in around the injured area; either the sensitiveness of the cortex increases so that repeated discharges of nerve-force take place without any apparent stimulus, or the circle of hyperæmia is spreading and now for the first time nvolves the motor area; whichever it may be, the prognosis is very grave, for though such injuries may end favourably, inflammation and suppuration sometimes occur, even when there is no fracture. If the first appearance is still further delayed, not perhaps until a month has passed, the suspicion of cerebral abscess at once arises.

The convulsions are always sudden, occurring without any warning; and hey may either be purely local, or, especially if they are repeated, they may spread from one centre to another, always extending in a definite and ntelligible order until they become general and involve the whole body. The ts may be momentary, or they may last half an hour or more; conscious ess is not lost, as a rule, unless they occur in rapid succession or become eneral; and they may either subside or end in paralysis. If the hæmor hage is extending each outbreak may be followed by a further diminution of onsciousness, and an increase in the area of loss of power, until at length oma and general paralysis occur together. General convulsions, resembling n epileptic fit, coming on immediately after an injury, may be the result ther of powerful stimulation of one part of the cortex only, or of rapidly creasing compression and anæmia. In the latter case they are followed by rofound coma.

(*b*) *Medullary lesions.*—Much less is known with regard to the symptoms nd localisation of these. Multiple contusions are not uncommon in the hite substance of the hemispheres, and if they interrupt the course of the bres from the cortex, the general effect is the same as if the centres them lves were destroyed; but unless the blood makes its way into one of the teral ventricles (which as the result of injury is very rare), and sets up compression, the extent of the hæmorrhage is never great. In fatal cases of concussion minute points of contusion are usually found, but it seldom happens that there are any very definite signs of their presence during life. Sometimes, however, there are symptoms which point to injury about the floor of the fourth ventricle; there may be persistent vomiting, possibly due to some irritation about the root of the vagus; or the pulse rate may remain abnormally slow, perhaps for the same reason; or there may be disturbances in the region of the vasomotor centre, giving rise to diabetes, polyuria, albuminuria, or hæmaturia.

Compression

In its most typical form, apoplexy for example, compression of the brain presents a striking contrast to concussion; but very often one can scarcely be distinguished from the other, and if, as not unfrequently happens, compression follows concussion before the rallying stage sets in, it may be impossible to say when the addition takes place.

Causes.—It may arise from injury, inflammation, or the presence of new growths. Extravasation of blood and inflammation are the most common causes. The former occurs either immediately after an accident, or within a very few hours, and may lie between the dura mater and the bone; in the subdural or subarachnoid space; in the substance of the brain; or in the cavity of the ventricles. Compression when due to inflammation does not appear until later. If the brain is involved primarily, as sometimes happens after concussion, there may be some indication of it within the first three or four days; if it is secondary, consequent on meningitis or acute suppurative ostitis, it rarely occurs for a week or more; and when there are no definite signs of it for weeks or months, it is probably the result of chronic abscess in the substance of the brain. Whether depressed bone by itself can ever give rise to general compression is very doubtful; when there is a tumour it is often present towards the end, especially if it is a rapidly growing one, or if there are hæmorrhages in connection with it.

The effect of pressure upon the nerve-centres depends to a great extent on the rapidity with which it acts. If it is sudden, convulsions and even an epileptic fit may occur before the function of the cortex is abolished; but this is more common in animals than in man. If it takes place slowly, the brain accommodates itself to the change so far as it can. In some cases as much as eight ounces of blood has been found, but probably the amount necessary to produce fatal compression varies very much in different individuals. The cerebrospinal fluid first makes way by flowing down the spinal sheath; then the smaller vessels in the brain become compressed; the stream becomes slower and slower, until it stops altogether. At first the effect is local, and limited to the region of the cause; but gradually it spreads to other parts that are to some extent protected by the falx and the tentorium; finally, the base of the brain becomes bloodless, convulsions perhaps set in, and life becomes extinct. Unless there is hæmorrhage into one of the lateral ventricles, compression is nearly always gradual, and leads steadily from impairment of function to complete loss, the higher centres suffering first; but in inflammation or abscess of the brain the last stages may be relatively very rapid. The chief difficulty arises from the fact that compression is seldom met with unmixed; nearly always it is associated with concussion, contusion, or hyperæmia, not unfrequently with all three at the same time.

Symptoms.—(*a*) When the compression is general they are very much the same, whatever the cause may be. The patient lies in a state of complete coma; voluntary movement and reflex excitability are both abolished; the limbs lie absolutely helpless, just as they are placed, and nothing that is said or done produces the least effect. The surface of the body may be cool, or bathed in perspiration; in some cases extreme high temperature has been noted. The breathing is slow and laboured, often stertorous from paralysis of the soft palate, and accompanied by a peculiar puffing in and out of the cheeks; the pulse is full and strong: the vasomotor and the cardiac centres in the medulla are both affected; the pupils are fixed and generally dilated, or one of them is dilated (generally the one on the side of the compression) and the other contracted; the urine is retained until the bladder becomes full, and the fæces are passed involuntarily. Convulsions are very rarely present unless the compression takes place suddenly, and then they are soon followed by coma and complete paralysis.

(*b*) In local compression, on the other hand, the symptoms depend upon the nature and position of the exciting cause, and consciousness is not lost. If the pons or medulla is involved, the effect, as may be imagined, is of the most serious character, threatening life from interference either with the nerve-centres themselves, or with the trunks on their way through the skull. The anterior part of the brain, on the other hand, may be almost destroyed without any definite local evidence, unless the third left frontal convolution is involved at its posterior extremity. Pressure upon the motor area of the cortex is the best defined, causing paralysis of the opposite side of the body, either of certain movements only, or of one limb, or of the whole side, according to the extent of the injury.[1] When the sensory zone is affected there is rarely any local evidence, although, as MacEwen has shown, a depressed spiculum from the inner table, driven into the anterior portion of the angular gyrus on the left side, may cause typical mind-blindness. In addition to these symptoms, which are directly dependent on the brain, there may be pain from the stretching to which the dura mater is subjected; or there may be evidence of pressure upon the nerves inside the cranium, choked disc, facial paralysis, or neuralgia corresponding to the fifth; or even the blood-vessels may afford some indication—the cavernous sinus, for example, may be compressed so that the eyeball is protruded and the veins of the orbit distended.

Diagnosis.—No absolute distinction can be drawn between *concussion* and compression. It is true the former is immediate, while the latter, as a rule, comes on gradually, and that loss of consciousness is rarely complete in the one, while coma is a symptom of the other; but when there is a condition of profound shock, such as often occurs after severe head injuries, it may be impossible to make an exact diagnosis, especially as one is not seldom only a prelude to the other. The same may be said of *contusion.* The effect on a centre in the cortex is much the same, whether it is crushed by an extravasation between the dura mater and the bone, or by one in its own substance; only in contusion monoplegia is either immediate or is preceded by monospasm, and extensive paralysis, especially hemiplegia, is uncommon; while in compression, pure and simple, there is usually an interval of a few minutes, or even of some hours, and the paralysis, if the symptoms are not masked by concussion, commences imperceptibly. Convulsions only occur in compression when it is rapid, and this rarely happens, for hæmorrhage into the lateral ventricles is not common as the result of injury, depression of bone is hardly ever sufficient, and bleeding on the surface or in the substance of the brain is nearly always gradual.

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[1] In one case under my care, in which the whole of the left side of the body was paralysed, more or less, consequent on a severe blow immediately in front of and above the right parietal eminence, there was a decided fall of temperature on the affected side. The patient was a child six years old; concussion was well marked, but passed off; symptoms of local compression followed and became more and more intense for forty-eight hours, affecting the face and tongue (very slightly), the arm (almost completely), and the leg. Twenty-four hours later the loss of power began gradually to disappear again.

Alcoholic coma, especially that which is induced by rapid spirit-poisoning, is sometimes mistaken for compression, particularly if there is an injury to the head at the same time; more often the converse happens. There is nothing in the temperature, or the pulse, or the respiration, that can be relied upon. MacEwen, however, has shown that in alcoholic coma the pupils, which are contracted to a pin's-point, very slowly dilate when an attempt is made to rouse the patient, and then, if he is left undisturbed, gradually begin to contract again, until in ten or twenty minutes they have resumed their former size. If there is any doubt the urine should be drawn off and examined for alcohol, which is often present in large quantities in these cases; but it must always be remembered that the two conditions may very easily occur together.

Opium coma, in the absence of history, is sometimes a little difficult to distinguish, though the diagnosis may be suspected from the peculiar character of the pulse and respiration and the fixed contracted condition of the pupils, unless they have become dilated again, as they do towards the end. In the case of laudanum the odour or the stomach-pump may make the question certain; but this fails completely with morphia, especially if it is injected subcutaneously. In *uræmia* the coma is not so continuous, there are epileptiform convulsions, the breathing is quiet, not stertorous, and there is no paralysis.

When compression occurs immediately after an accident, without any interval, it can only be the result either of very extensive depression of bone, or of extravastion of blood, either into the cavity of the lateral ventricles or at the base of the brain. If it is more gradual, if it does not make its appearance for some minutes, or even for some hours, the extravasation is either between the bone and the dura mater, in the subdural space, or in the substance of the brain. Of these the two former cannot be distinguished from each other; the last may be suspected if there are signs of cerebral irritation in addition to those of compression, or if the patient does not regain consciousness after the accident.

Compression following inflammation of the meninges is always general; that due to cerebral abscess or tumour may be local at first; in either case the diagnosis must be based upon the previous symptoms.

Wounds of the Brain

Incised, punctured, and contused wounds of the dura mater and the brain are not uncommonly met with in conjunction with fracture of the skull. They may be produced by cutting instruments, such as knives and sabres, penetrating the bones, or even slicing off a portion of the skull and the brain beneath it; or by blunt weapons, such as sticks or slate-pencils, driven through either the roof of the orbit or the cribriform plate of the ethmoid, often without any apparent external injury; more often still by fragments of bone driven inwards; or as a result of gunshot injuries. These last are, generally speaking, fatal at once; but instances in which small revolver bullets have entered the skull and have remained lodged in the substance of the brain for years are not uncommon.

The cortex is the part that is usually affected; the base rarely suffers except in gunshot injuries through the mouth; and the immediate symptoms depend upon the extent and locality of the injury. As a rule there is no difficulty in the diagnosis, but in some cases of depressed and punctured fractures the rent in the dura mater may lie concealed beneath an overhanging margin of bone, and be overlooked if this is not elevated. The prognosis is always grave, even when the injury is so slight that there is no immediate risk to life; foreign substances are often carried inwards—bullets, fragments of bone, hair, even portions of a hat; the wound is exceedingly difficult to clean thoroughly; in many cases—as, for example, gunshot injuries—no attempt can be made; it is, generally speaking, more or less valvular, that is to say, there is a small opening in a tough unyielding membrane leading into a space filled with broken-down brain-substance and extravasated blood, and inflammation of the membranes or of the brain and hernia cerebri are proportionately likely to occur.

Intracranial Hæmorrhage

This may take place, as already mentioned, between the dura mater and the bone; in the subdural or the subarachnoid space; in the substance of the brain itself; or in the cavity of the ventricles; and it may occur rapidly when there is a large space for it to collect in or when a large vessel is torn across; more often it takes place slowly and continues until either the tension and the coagulation are sufficient to close the vessels or fatal compression is induced.

1. Hæmorrhage between the dura mater and the bone may occur from injury to one of the venous sinuses, but it is rarely of any surgical importance unless it is caused by rupture of the middle meningeal artery or its anterior branch: then it gives rise to a series of symptoms which may be taken as the type of those of compression.

It may be produced either by direct violence or by a fissure extending from the vertex; sometimes the force of the blow is exceedingly slight, and there is no concussion, or only a transient sense of giddiness; and it is said to have occurred without fracture of any kind being detected. Generally speaking the extravasation takes place on the same side as the injury; but the opposite artery may be torn if the fissure extends across the base of the skull, and possibly in fracture by *contre-coup*. In a characteristic case the patient is stunned for a time and gradually regains consciousness. Then, after an interval sometimes of half an hour, sometimes of a day, symptoms of compression begin to set in. The patient becomes drowsy; the muscles on the opposite side of the body begin to lose power, those of the face perhaps first, then those of the neck and arm, and finally the leg and trunk; the pulse becomes slow and full; the drowsiness deepens into coma; the respiration becomes stertorous and the compression complete. Convulsions are not generally present, though I have known them brought on, in a case of comminuted fracture associated with only meningeal hæmorrhage, by pressure with the finger over the seat of injury. The eyeball on the injured side is sometimes protruded, probably from pressure upon the cavernous sinus, causing congestion of the orbit; and, what is of very great significance, the pupil on the same side (opposite to the hemiplegia) is dilated. It is said that this is due to pressure upon the trunk of the third nerve, and that it may be preceded by a transient contraction, pressure when it is slight first acting as a stimulus, and then as it increases destroying the conducting power; but it may certainly occur when the extravasation is nowhere near the course of the nerve. The diagnosis can only be certain when there is a distinct interval after the concussion, and when the compression begins locally and spreads gradually without there being any evidence of cerebral contusion or irritation. If the latter is present the subcranial hæmorrhage is probably associated with cortical or subarachnoid, or these may be present alone.

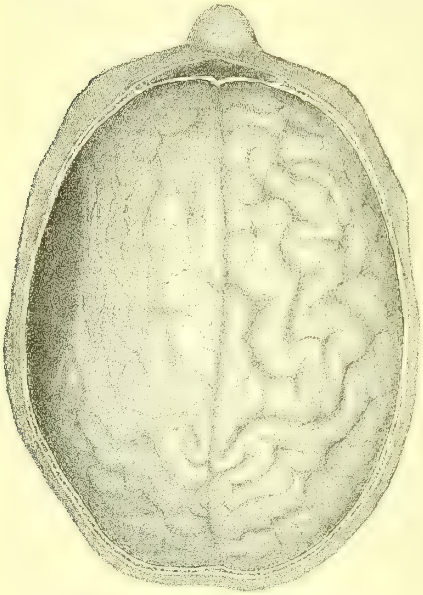


Fig. 273.—Hæmorrhage from the middle meningeal artery.

Subcranial extravasation, due to rupture of the middle meningeal artery, forms a black granular clot of peculiar solidity and hardness between the dura mater and the bone. It is usually disc-shaped, three and even four inches across, thickest at the centre, sometimes as much as an inch, and thinning off towards the margin. There is a cup-shaped depression to correspond on the surface of the brain, and all the convolutions are flattened down. If not so large as to cause fatal compression, the coagulum may become absorbed, but only after a long time.

2. Subdural hæmorrhage is rarely met with by itself and cannot be distinguished from other forms. Nearly always it is secondary to cortical and subarachnoid extravasation, and adds the element of gradually spreading compression to the other symptoms. The blood comes either from the vessels of the pia mater or cortex, the arachnoid being torn across, or from the large veins on the upper surface of the brain, which sometimes give way just where they enter the superior longitudinal sinus. More rarely the dura mater is wounded, and the bleeding proceeds from the meningeal arteries or the venous sinuses. When it occurs by itself, the blood gradually

extends over the surface of the hemisphere and does not remain localised or become hard and dense as in the subcranial form. The vessels are smaller and the tension of the extravasation not so great. The symptoms are the same as those of subcranial hæmorrhage, and, like them, come on slowly and gradually, but they are more vague, the compression is incomplete; there is stupor, lasting perhaps for days or even weeks, but not necessarily coma; there may be loss of power over certain muscles, or even over one side of the body, but there is no well-defined paralysis. If the patient survives, cerebral hyperæmia and irritation are almost sure to set in; headache, irritability, spasmodic contraction of the muscles, even general convulsions may occur; and there is always a certain degree of fever and some risk of inflammation. Recovery in these cases is always very slow and often remains imperfect; the blood may be absorbed completely, but it often forms a false membrane adherent to the dura mater or arachnoid, at first soft and vascular, later becoming tough and hard; or it becomes organised into a cyst, which at length loses its colour completely, becomes transparent, and floats free in the arachnoid space. Memory often remains defective; or the patient becomes liable to violent outbreaks of passion, or there may be complete loss of self-control; and even insanity and epilepsy have been known to declare themselves at length.

3. Subarachnoid hæmorrhage is practically always associated with severe injury to the cortex, and is secondary to it; often it extends into the subdural space as well. The blood, if the arachnoid does not give way, pours down into the sulci and over the convolutions, until it may reach the big subarachnoid space at the base of the brain. There are no symptoms which are peculiar to it; if, however, after an accident there is evidence of severe contusion to one part of the brain, and if the symptoms, local at first, rapidly become general, involving one centre after another in quick succession, causing first convulsions and then paralysis, it may be conjectured that extravasation into the subarachnoid space is part at least of the injury present.

4. Cerebral hæmorrhage when slight rarely admits of diagnosis. There is little doubt that minute extravasations are present in all cases of concussion, but, as a rule, they give rise to no special symptoms. When they are extensive—when, for example, a diseased artery gives way under a sudden shock and the extravasation bursts into one of the ventricles, causing an apoplectic fit—the symptoms are altogether general; there is no local indication of any kind.

Injuries of Nerves

The cranial nerves may be injured either at their deep origin or in their course through the cranium. They may be torn across in fractures of the skull, or compressed by an extravasation of blood around them or in their sheath; or later on they may be affected by a neuritis, which commences gradually, lasts a few weeks, and generally disappears again.

The olfactory may be injured in fractures of the anterior fossa; sometimes complete anosmia occurs without any evidence of injury to the bone, possibly caused by momentary separation of the bulbs, tearing across the nerves at their origin.

The optic is frequently affected. If the tract is injured, there is loss of sight in the corresponding half of the field of vision of both eyes—lateral hemiopia; if the chiasma itself, either the inner or the outer side of both retinæ is blind, according to the position of the lesion. The trunk of the nerve may be torn across at the optic foramen, or crushed by a splinter of bone, leading to simple atrophy and complete blindness; or hæmorrhage may take place into the sheath, so that compression of the nerves and choked disc are produced at once; or, later, if meningitis or cerebral abscess occurs, double optic neuritis may set in.

Paralysis of the third nerve gives rise to ptosis, immobility of the eyeball in the position of external strabismus, dilatation of the pupil, and loss of power of accommodation. Sometimes the eyeball appears slightly too prominent. If the injury is in the crus there is coincident hemiplegia of the opposite side. Paralysis of the fourth merely affects the superior oblique, so that there is diplopia or looking downwards; giddiness, when going down stairs, is often the first thing noticed. The sixth, which supplies the external rectus only, is injured more frequently than any other of the orbital nerves. Injury to the fifth nerve at its origin, with complete anæsthesia of that side of the face, may occur in gunshot injuries through the mouth; but the lesion generally proves fatal in a few hours. When the sensory divisions are affected after their separation, there may be intense neuralgia from irritation of the fibres or complete anæsthesia. If the latter persists the skin on that side of the face becomes cold and purple; the conjunctiva loses its sensibility and becomes inflamed; the lachrymal and salivary glands cease secreting; and there is complete loss of smell and taste on that side from the dryness of the mucous membrane. The anæsthesia and trophic influences are more marked when the injury is peripheral than when the origin of the nerve is involved. Paralysis from injury to the motor portion is rare, but may be diagnosed from the irregular character of the movements of the lower jaw.

The facial, which is frequently involved in fractures through the middle fossa of the skull, may be injured at its origin, in the meatus, or in its course through the aqueduct. In the first case the sixth usually suffers as well, and there is hemiplegia of the opposite side of the body; in the meatus the auditory nerve is either torn or compressed at the same time, so that there is deafness on that side; in the aqueduct the paralysis is limited to the muscles of expression, and if the petrosal nerves are injured to those of the soft palate. Deviation of the velum, however, may occur in paralysis of the fifth, the glossopharyngeal, and even, it is said, the hypoglossal. Loss of the sense of taste is usually present when the chorda tympani is injured. If the nerve is only compressed by extravasation or exudation, the symptoms are not immediate; they come on by degrees and gradually disappear again. In a few cases neuritis sets in afterwards.

The other cranial nerves are rarely hurt in fractures of the skull unless the injury is of extreme severity; but it is not improbable that some of the instances of remarkably slow pulse, of constant vomiting, of peculiar respiratory rhythm, and of such vasomotor disturbances as diabetes, or polyuria, may be due to deep-seated extravasation near their nuclei of origin.

General Treatment of Injuries of the Brain

Injuries of the brain may either prove fatal at once from the extent or the situation of the laceration, or death may ensue in the course of a few hours or days from shock, inflammation, or compression; or at a much later period secondary complications may set in—softening, cerebral abscess, or epilepsy, and lead at length to the same result. No injury of the brain, no matter how trivial it appears to be, even if it is only attended by a transient giddiness, should be neglected.

Concussion.—The collapse of the first stage of concussion may be merely momentary, or may last for hours. In exceptional cases it may terminate fatally, either at once or after a couple of days, without the patient ever having rallied. The state of the pulse, therefore, requires to be very carefully watched. In most instances stimulants are not only unnecessary but absolutely injurious; the danger is that the symptoms of reaction and the hyperæmia that attends it may run on to inflammation, or that the bleeding may continue, and undoubtedly they would encourage this; but every now and then cases are met with in which they seem indispensable; the heart will fail without; and it must not be forgotten that the mere prolongation of the period of collapse is in itself a source of danger, and tends to aggravate the intensity of the reaction when it once begins.

The patient should be placed in bed with the head low, wrapped up in warm blankets and surrounded with hot-water bottles; then, as soon as he can swallow, a small quantity of hot tea or coffee may be given. In the vast majority of cases the collapse passes off of itself without anything further being required; if the condition of the pulse becomes alarming, some good may result from the rectal injection of hot water, or the hypodermic injection of atropin ($\frac{1}{200}$ grain); if it distinctly begins to fail, ether or ammonia must be given at once; and if these do not succeed, brandy must be injected subcutaneously. Cases of this kind, however, in which the collapse is so intense, are fortunately very rare.

As soon as reaction commences every effort must be made to keep the hyperæmia within bounds. The room must be darkened, all noise prevented, conversation absolutely forbidden, and complete rest in the recumbent position insisted on. In severe cases the head should be shaved, Leiter's coils applied, and if there is much aching, or if the temperature rises more than a degree, leeches should be placed behind the ears. Milk and beef-tea only should be allowed, and in small quantities; and the bowels should be opened as soon as possible, either with five grains of calomel or with a minim of croton oil. The former may have some influence on inflammatory exudation, but in addition it is no slight advantage that it may be placed upon the tongue of a person who is insensible with perfect safety, and that there is little risk of its being vomited. If this does not succeed, if the temperature continues to rise, and particularly if the head begins to throb and beat, there should be no hesitation in making use of venesection, and withdrawing six or even ten ounces of blood. Whatever may be the way in which this acts, there is no doubt that it sometimes stops incipient delirium at once.

In the case of children with slight concussion it is very difficult to keep them in bed more than two or three days; in more severe cases, especially adults, and where, from the continuance of the symptoms, it is morally certain that there has been some considerable contusion of the brain, and that it has been followed, as contusions are in every part of the body, by hyperæmia and exudation, rest in bed must be insisted upon, until every sign of the mischief has disappeared. This rarely happens under a fortnight, in many cases not for three or four weeks; and until then no precaution must be relaxed.

Compression.—The treatment of compression of the brain depends upon what can be found out from the history and the symptoms with regard to the locality and nature of the cause.

1. Where it is either general from the first, or where there is no definite evidence of local origin, surgical interference is out of the question. If it is recent, within a few hours of an accident, and therefore probably due to hæmorrhage, means must be taken to render the return of venous blood from the head as easy as possible by position, and possibly by venesection (though this is not of such service here as it is in controlling the commencement of inflammation); to favour the absorption of cerebrospinal fluid by free purgation; and to diminish the amount of blood going to the head as much as possible by the application of cold. If some days have passed since the accident, and symptoms of inflammation are already present, the same remedies may be employed, with in addition the free use of mercury, but with very little hope. The compression in either case is only a late symptom of an injury over which we have at present little or no control.

2. Where, on the other hand, the signs point to some local cause, and where the nature of the case is such (as it nearly always is when the compression is the result of accident) that there is but slight prospect of spontaneous improvement, means must be taken as soon as possible to relieve the brain.

(*a*) If the symptoms are immediate they may be due to depression of bone. Mayo Robson has recorded a case in which brachial monospasm and monoplegia were caused by this, and relieved almost at once by trephining ten days after the accident. The dura mater was intact and there was no evidence of subdural hæmorrhage or of cortical bruising. Whenever anything of this kind can be ascertained, the depression must be elevated, and the sooner the better; the longer the case is left the greater the risk of inflammation breaking out, or of a discharging lesion being set up in the cortex, so that, after the original cause has been removed, epileptiform convulsions continue.

(*b*) If the symptoms do not set in at once, if there is a distinct interval of partial or complete return of consciousness, without any evidence of cerebral irritation, there is probably subcranial hæmorrhage, with, exceptionally, subdural in addition. It may come from the anterior division or the trunk of the middle meningeal: more rarely from its posterior division or the lateral sinus; very rarely from any other vessels.

Hæmorrhage from the middle meningeal is not necessarily fatal, from the anterior division at any rate; but it is so in the great majority of instances, and consequently, if the diagnosis is clear and the symptoms show that the extravasation is extending, an attempt should be made to check it either by ligature of the external carotid artery, or by trephining. The former operation has not been tried sufficiently often to justify its recommendation; the latter may be carried out without much difficulty, so long as the case is recent. If there is an external wound this should be made use of; if there is not, the artery may be found midway between the auditory meatus and the external angular process of the frontal bone, an inch or an inch and a half above the level of the zygoma. A triangular flap, comprising the skin, the temporal aponeurosis, the muscle and the periosteum, is reflected downwards from off the bone, and the surface of the greater wing of the sphenoid and the inferior angle of the parietal examined. If there is a fissure, the point of the trephine is applied over the spot where the fracture and the line of the vessel intersect each other. As soon as the circle is removed a dense, almost black, coagulum presents itself in the opening. This has to be literally scraped out, and often it is necessary to enlarge the opening in one or other direction by means of Hoffmann's forceps in order that this may be done effectually. A greater difficulty is to secure the bleeding point. The artery is superficial only where it occupies the canal in the parietal bone; for the rest of its course it lies in the dura mater, and this, with the brain, is pushed away from the skull by the coagulum. In recent cases the brain may rise up again as soon as the clot is removed, but this is not invariable, especially if the injury is of some days' standing; or the trephine opening may not have exposed the wound in the vessel; or the cavity fills up again with blood as fast as it is emptied, so that the bleeding spot cannot be seen. Ice-cold water, and pressure upon the carotid, are usually sufficient to check the hæmorrhage for the time; but if the bleeding point is not exposed, it is better to enlarge the trephine opening until it can be found and ligatured. If this is not done, the bleeding is very likely to return as soon as the parts are restored to their position and the normal temperature is regained. Afterwards the wound must be well washed out with corrosive sublimate or some other antiseptic, the whole of the clot removed, and free drainage provided for from the posterior extremity. If the cavity is a large one, it is advisable to make a second opening in the bone.

If instead of the clot presenting in the wound the dura mater is dark purple in colour, and is forced up into the opening without the normal pulsation being perceptible, it is probable there is subdural hæmorrhage. This, if the pressure symptoms are so severe as to threaten life, must be treated in the same way as subcranial: the opening in the bone must be enlarged to a sufficient extent, the dura mater incised and reflected in a flap so arranged as not to injure its own vessels, the clot washed away, or, if the arachnoid is injured, carefully picked off, and then the membrane, the bone so far as possible, the pericranium and the skin, carefully replaced and sutured to their corresponding parts, one by one, an opening for a drainage-tube being left at the spot that is most dependent when the patient is lying down.

Even when there are symptoms of cerebral irritation and laceration in addition to those of compression, the treatment must be conducted on the same principles so long as there is evidence that the injury is local. If it is general, nothing can be done; but if local convulsions occur, and if they spread and involve other groups of muscles in definite order, and particularly if every convulsive fit is followed by an increase in the area of paralysis and a further diminution of consciousness, so that it is almost certain, not only that there is an extravasation of blood involving a particular portion of the cortex of the brain, but that it is spreading and that it will inevitably result in fatal compression, the question arises whether it is not advisable to trephine and explore. Cold, bleeding, first local and then general, profuse purging with calomel, or, if there is no time for that to act, with croton oil, and internal remedies that assist in causing hæmostasis, may be tried; but if the symptoms persist, and particularly if the compression is extending, there can be little doubt as to the ultimate result if the case is left to itself. Everything depends upon an exact diagnosis of the locality; and of course this is only practicable when certain portions of the brain are involved, and when there has been an interval of at least partial consciousness since the accident. The history is of the utmost importance: the condition of the scalp and skull must be thoroughly examined, as well on the sound side as on the injured one, and the closest attention must be paid to the course the symptoms take. In such a case, where everything points to an injury that is local at first, and where the prognosis admits of little doubt, the scalp should be reflected, bringing the pericranium with it; a large opening should be made with the trephine, unless, as probably happens, the bone is already comminuted, and if the dura mater bulges into the wound or appears purple in colour from the extravasation beneath, or if when it is touched spasmodic contractions make their appearance in any of the muscles, it must be reflected as well, the clot turned out from beneath, and the seat of hæmorrhage exposed. Such cases must always be rare, for unless consciousness returns, for a time at least, it is scarcely possible to prove that one portion of the cortex has been involved; and it is absolutely beyond our power to show that there are no deeper lesions.

TRAUMATIC EPILEPSY

Injuries of the head are occasionally followed by epilepsy. Generally it does not make its appearance for some time after the accident; and at first the fits are slight and infrequent, not attended by loss of consciousness; but as time passes the frequency and intensity increase, until at length they end in permanent impairment.

The severity of the accident does not appear to have anything to do with it; and in many cases the immediate cause seems rather to be an injury to the coverings of the brain than to the brain itself. In some cases the cicatrix on the scalp is tender and sensitive, with a constant sense of burning; pressure on it may cause a fit; or an aura may start from it. In others some injury to the bone seems to be the exciting cause; it may be thickened or hardened; or there may be irregular nodules on its inner surface; or there may have been inflammation, leaving a sequestrum. In others again the stimulus proceeds from some affection of the membranes; the dura mater has been found thickened and yellow; sometimes it is adherent to the cortex; or it has undergone calcareous degeneration; or there is a cyst, possibly developed from a blood-clot, upon its inner surface.

In another class no lesion can be found in any of the structures that cover in the brain. The exciting cause is in the cortex itself; and if the affected part lies in the motor area, if the spasm always starts in certain muscles, or extends in a certain order, the exact spot may be defined without reference to the injury. There may be no gross lesion perceptible in the brain; but that the disease is dependent upon some alteration in this particular part is clear from the fact that excision of it is followed by complete and, in some cases at least, permanent cessation of the fits.

Treatment.—If it can be shown that the convulsions are excited by a local irritation anywhere, the part should be excised without delay. In the case of injury the superficial scar should be removed altogether, the bone beneath carefully examined, and, if there is the least suspicion of any alteration, trephined. Where it is thickened or otherwise affected, and where the dura mater appears healthy beneath, this may suffice; but if the membrane is marked with scar-tissue, or if it is yellow, or if it is fixed down to the cortex, it should be cut away from under the trephine-opening and the adherent portion of brain removed with it. It is true that when the motor area of the cortex is excised loss of power in the corresponding muscles follows; but as a rule this is only temporary, and even if it were permanent the cost would be slight. Hughlings Jackson and Ferrier have shown, in non-traumatic cases, that the removal of an epileptogenous focus in the cortex of the brain (if it can be localised) is not only justifiable, but called for, whether any gross lesion, such as scar-tissue or tumour, can be found or not; and when there is in addition the evidence of injury to assist in the diagnosis of the situation, there should be no hesitation. One or two convulsive spasms not unfrequently occur after the operation, but in many cases the improvement has not only been marked, but has persisted.

This operation must be clearly distinguished from that performed by Arcilza, who, in a case of true epilepsy, commencing with convulsive movements of the left arm, extirpated the whole of the brachial motor area on the right side. Paralysis followed, and as this passed off the convulsions returned as badly as ever.

Traumatic Insanity

This does not occur so frequently as epilepsy, but there are several cases recorded in which it has followed injuries of the head. Byrd has reported four in which the operation of trephining was performed: one died; one improved for a time: and two are stated to have entirely recovered.

Section III.—Diseases of the Head

DISEASES OF THE SCALP

Eczema

A pustular form of eczema is exceedingly common in children, and is very often associated with enlargement, inflammation, and even suppuration in the occipital, mastoid, and posterior cervical lymphatic glands. It is undoubtedly more common in scrofulous subjects, and it may, by the changes it induces in the skin and in the lymphatic glands, assist tubercular infection, but there is no proof that it is itself tubercular. The hair should be cut short; the scabs removed by soaking them well with oil, or by applying boracic fomentations; and the surface, when thoroughly cleansed, dressed with an ointment of nitrate of mercury, acetate of lead, or zinc. Careful examination for pediculi and their ova should be made in all cases.

A pustular syphilide, occurring round the roots of the hair and leading to the formation of thick scabs and crusts, is very common in the secondary stage, and must not be mistaken for this.

Erysipelas

This is usually met with as a complication of wounds: even in the so-called idiopathic cases it is probable that there is some scratch or abrasion.

It does not differ in any essential respect from the same affection in other parts of the body; but owing to the anatomical structure of the scalp, the local signs, the swelling and redness, are generally ill-defined, while the constitutional ones, especially those which, like the headache, wandering, and drowsiness, may be referred to the disorder in the subjacent structures, are unusually prominent. The prognosis is always grave, owing to the possibility of cerebral complications.

SUPPURATION

This may be either diffuse or circumscribed. The former is exceedingly grave, owing to the rapidity with which it spreads through the loose subaponeurotic layer. The inflammatory products, unable to escape, make their way in all directions under the tendon of the occipito-frontalis, spreading down into the eyebrows in front, to the superior curved line of the occipital bone behind, and as low as the zygoma at the sides. The whole surface of the head becomes swollen and puffy. The skin is hot and exceedingly painful; at first, owing to the dense aponeurosis between it and the seat of inflammation, it is white and tense; later, if left, it becomes soft and boggy; red patches form in the temporal and mastoid regions; and finally it gives way, allowing the escape of an immense amount of pus, mixed with shreds and sloughs. The constitutional symptoms are most severe: the headache is intense; the temperature many degrees above normal; and wandering and delirium are rarely absent. If left to itself, the whole of the cellular tissue beneath the aponeurosis may gradually come away, and after a prolonged illness, the opposing surfaces may grow together; or the skin and the pericranium may slough, leaving large districts of the cranial bones deprived of their blood-supply; or the inflammation may spread along the emissary veins into the diploe, causing osteophlebitis; or meningitis, thrombosis of the sinuses, and pyæmia may follow.

The cause is nearly always the sealing up of an imperfectly cleansed wound. There is no harm in sutures if the injured surface is thoroughly washed out and a loophole left at the most dependent angle for drainage; but at the first sign, if there is any rise of temperature, or the least tenderness by the side of the wound, one or two of the stitches should be cut, and the edges gently separated with a probe. Probably a small bead of pus will escape, and all will be well. If this stage is past and the inflammation is already diffuse, the whole wound should be reopened; incisions, parallel to the main vessels, made wherever there is the least sensation of bogginess, and warm boracic fomentations applied to encourage the discharge. If the vitality of the tissues is not already broken down, they will begin at once to throw off the poison and protect themselves with a layer of vascular granulations. Convalescence, however, is always very protracted; drainage requires careful watching; the scalp itself may need to be fixed by strapping; the sloughs often take a long time separating; and, as a rule, the patient's constitution is not of the best.

Circumscribed suppuration may occur in the skin and subcutaneous tissue; deeper, in the subaponeurotic layer; or between the pericranium and the bone. Abscesses that form in the loose cellular tissue may be of considerable size; the others are smaller, but are much more painful.

Suppuration beneath the deep temporal fascia is difficult of diagnosis, owing to the tenseness of the membrane over it; and sometimes, for the same reason, the constitutional symptoms are very severe. The pus usually tends to gravitate downwards beneath the zygoma, but the opening should be made above it, as soon as there is any feeling of bogginess or of deep-seated fluctuation.

TUMOURS OF THE SCALP

1. *Congenital*

Nævi are exceedingly common, both the cutaneous and the venous form, but they do not require any special treatment.

Dermoid cysts, containing fine hairs as well as sebaceous matter, frequently occur at the outer angle of the orbit, and sometimes are found elsewhere along the lines of union. For the most part they are small, seldom exceeding half an inch in diameter; but they may be deeply seated, lying in little recesses in the bone, or even in perforations extending right through, so that they are in contact with the dura mater. As a rule, they are better left alone.

2. *Acquired*

Sebaceous cysts, developed in connection with the hair-follicles, and showing their origin by the small black dot upon their surface, are very common after adult life and not unfrequently are multiple. They lie just beneath the skin, to which they are closely adherent. The small ones are firm and dense; as they grow larger and project farther above the level, the contents become softer and the skin that covers them thinner, so that the hair-follicles waste away and the hairs fall off; and sometimes at length they rupture and discharge a thin fluid mixed with sebaceous matter and crystals of cholesterin, often of a peculiarly offensive odour. This is especially likely to occur if they are injured or if they become inflamed; and then the nterior begins to throw out granulations and forms a fungating vascular mass, which, in appearance, closely resembles epithelioma, and possibly may in some cases pass into it.

These cysts should always be removed before they become inflamed. The simplest way is to make a linear incision through the skin over them, down to, but not into the cyst-wall, and then quickly isolate them by eparating the soft cellular tissue on either side with the handle of the calpel. The larger ones, however, and those which have been inflamed must be transfixed, emptied by squeezing, and then dissected out, the edge f the wall, where it has been divided, being firmly grasped with a pair of orceps. In no case may any portion of the cyst be left behind, or union ill not take place.

Horny excrescences are occasionally produced from sebaceous cysts that ave ruptured or been opened. The sebaceous material on the outside dries p and shrinks into a kind of horny layer, while a fresh production is ontinually going on at the base. In some cases they attain a length of veral inches.

Other varieties of tumour are rare in comparison. *Cirsoid aneurysm* ay occur; circumscribed *fibroma* is occasionally found, and there are a few stances on record of an enormous diffuse growth of fibrous tissue, forming great pendulous masses (*pachydermatocele*). Probably it is akin to elephantiasis, and may be congenital. *Epithelioma* and *rodent ulcer* are sometimes met with, but *sarcoma*, with the exception of those forms which originate in the bone or dura mater beneath and involve the scalp secondarily, is very uncommon.

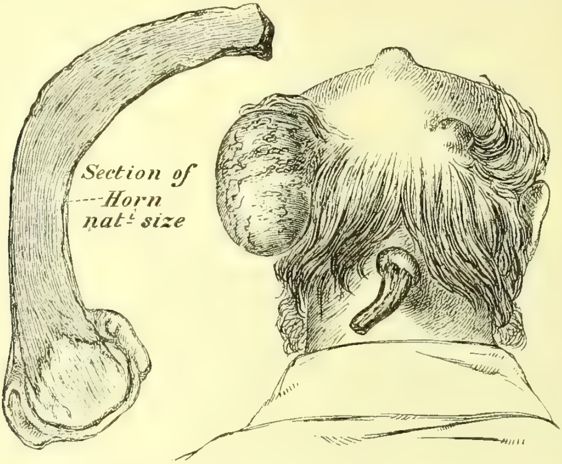


FIG. 274.—Sebaceous tumours in scalp, and horn.

DISEASES OF THE BONES OF THE SKULL

HYPERTROPHY

In ostitis deformans the vault of the cranium is usually immensely thickened. The inner surface becomes irregular and is marked all over by arborescent grooves; the outer remains smooth and even; the diploë disappears, and on section the bone is hard and dense like ivory. Beyond a gradual increase in the circumference of the head, it does not appear to give rise to any symptoms; and no treatment is of any avail. Other forms of enlargement are described under Diseases of the Bones.

RICKETS

A peculiar form of atrophy of the inner table, known as *craniotabes*, is occasionally met with in infants suffering from rickets. It affects especially the posterior inferior angles of the parietal bones and the tabular part of the occipital, probably because of the recumbent position of the child, for a certain flattening of that part of the head is not unfrequently noticed at the same time, and in one or two instances, in which the disease existed before birth, a similar change has been found on the inner surface of the vertex. The sulci for the cerebral convolutions are unusually plain, and here and there are marked in their course by little conical pits, which, in some places, are so deep that nothing but a parchment-like layer of dura mater and pericranium is left: the whole thickness of the bone is absorbed. Sometimes in addition there is a granular deposit of new bone under the pericranium on the outer surface, and occasionally a very considerable amount round the fontanelles and along the sutures, sufficient to be felt plainly through the scalp.

In all probability it is due to the effect of continued pressure acting on softened hyper-vascular bone. It certainly may occur independently of hereditary syphilis, although it is often associated with it (e.g. Parrot's nodes), and a few instances are recorded in which other evidence of rickets was unusually slight.

The diagnosis can only be made in well-marked cases by the peculiar parchment-like yielding on pressure with the fingers. No special treatment is required.

Inflammation

Inflammation of the bones of the cranium may be caused by mechanical injury, by the products of septic decomposition, and pyogenic micrococci; and by syphilis, tubercle, and occasionally other specific diseases.

(*a*) Simple inflammation (*rarefying ostitis*) may result from mechanical injury, if it is sufficiently persistent in its action, but naturally such conditions are rare in connection with the cranium. It may, however, occasionally be seen when a portion of bone which has been killed by external violence is quietly removed and detached without suppuration. The tissues around become soft, vascular, and filled with lymph; the bone immediately adjacent to the portion that is dead is absorbed and replaced by a layer of granulations, and at length the sequestrum is loosened, and, as soon as the condition of the scalp will allow it, thrown off. Suppuration is usually present in these cases, but it is an addition and not in any way essential.

The portions of bone that are reimplanted after trephining sometimes behave in the same way. In many instances they contract adhesions to the structures around; in some they appear to become welded together by masses of new bone, although this is not quite certain; but in others they cause a certain degree of irritation: vascular granulation-tissue is formed around them; if the constitution is sound and the tissues healthy, they are absorbed; if, on the other hand, the irritation is too great for the tissues to bear, pyogenic micrococci find their way in and cause suppuration, exactly as they do round buried sutures and old sequestra.

(*b*) *Suppurative ostitis* is rarely met with except in compound fractures and the later stages of tubercular or syphilitic caries, after pyogenic organisms have gained entrance as well as specific ones. Exceptionally it may follow a simple contusion, the pyogenic germs being carried to the injured spot by the blood-stream (as in Pott's puffy tumour), singly, or, as in pyæmia, in the form of emboli. In any case, there is very grave risk of extension to the meninges on the one hand and the emissary veins and venous sinuses on the other.

(*c*) *Tubercular caries* of the vault of the skull is rare, even in childhood, and is seldom recognised until the skin has given way and left a tuberculous ulcer, the floor of which is formed of softened carious bone.

(*d*) *Syphilitic ostitis* is exceedingly common in all stages of the disease.

Intensely painful periosteal nodes are often present during the secondary period. There is very little swelling, but the most extreme tenderness, so that the patient will not allow a finger to come near. Possibly the severe local headache that occurs sometimes about the same period may be due to a similar affection of the dura mater.

Gummatous deposits, leading to caries and necrosis, are even more common in the tertiary and late hereditary stages. There may be merely a soft and tender swelling on the scalp, or an ulcer with a base of carious bone and undermined overhanging edges; or half the frontal bone may be bare, black, and dead, even through its whole thickness, while the skin around is thickened and curled inwards, as if it had shrunk away from the centre as soon as the tension on it had yielded. Immense portions of bone may be lost in this way, and it may be years before the sequestra separate. No new bone is ever formed; and deep radiating cicatrices, through which sometimes the pulsation of the brain can be felt, are left, causing the most hideous and characteristic deformity.

In other cases, corresponding to the diffuse gummatous infiltration of other organs, the diploë becomes completely obliterated, so that the bone on section is solid throughout and exceedingly dense and hard; and occasionally, in addition, great bosses are developed from the inner surface, especially over the frontal region, so that the grooves for the sinuses and the meningeal arteries become deep channels.

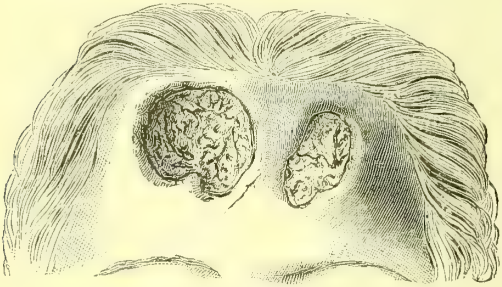


FIG. 275.—Syphilitic necrosis of the frontal bone.

Parrot's nodes, periosteal thickenings of soft vascular new bone, arranged in lamellæ, are characteristic of the hereditary form. They occur round the anterior fontanelle, one on each parietal bone, and one on each half of the frontal, seldom invading the normal centres of ossification, and leave a cruciform sulcus in between, the so-called natiform skull. Occasionally this is associated with wasting or gelatiniform degeneration affecting the posterior portion of the skull, but distinguished from craniotabes by its occurring on the outer surface. For a further description see Syphilitic Diseases of Bone.

Treatment.—The constitutional treatment varies naturally according to the cause. The local is much more simple. Free exit must be given to all discharges; sequestra removed as soon as they are loose; and decomposition prevented by proper drainage and antiseptics. Tubercular caries can sometimes be greatly benefited by free scraping and the application of iodoform. Sometimes exfoliation may be assisted by the use of strong sulphuric acid; and occasionally trephining is necessary, either to drain an extradural collection of pus, or to release a fragment that is locked in, owing to its peculiar shape.

TUMOURS OF THE CRANIUM

Osteomata and sarcomata are the most common. Carcinoma only occurs as a secondary deposit or by extension. Hydatid cysts and angeiomata have occasionally been described.

Osteomata.—Those growing from the outer table are sometimes called exostoses; those from the inner and diploë, enostoses. Most of the latter are, however, inflammatory and probably syphilitic.

Cancellous exostoses upon the cranium are rare; ivory ones are more common, growing chiefly from the frontal bone and in the external auditory meatus. Sometimes they are multiple and symmetrical. As a rule they are of very slow growth and should be left alone; but when they grow in the frontal sinus they may cause the most fearful disfigurement from displacement of the eyeball, or even more serious symptoms from pressure upon the brain; while in the ear they may lead to deafness and ultimately to complete obstruction of the meatus, with its consequences (acute suppurative ostitis and meningitis) if the secretion collects behind and decomposes.

Fortunately it frequently happens that the necks of these growths are much more slender than would be imagined from their size, so that they have even been known to break off. As a rule, they can be detached with a drill fitted to a surgical engine, but very great care is required in the selection of proper instruments. In one or two instances the growths have detached themselves, like the antlers of a stag, the vascular canals in the neck gradually becoming smaller and smaller until at length the blood-supply is altogether cut off.

Sarcomata.—Spindle-celled and myeloid sarcomata occasionally grow from the diploë and cause expansion of the outer table. In some cases, the two tables are widely separated from each other, and the intervening space traversed by a complex arrangement of radially arranged trabeculæ. Occasionally the bone gives way and the growth spreads rapidly under the skin, or compresses the dura mater and the brain according to the direction it takes. There is usually a good deal of pain at the first, and the symptoms may be masked to a considerable extent by the inflammation around.

Sarcoma of the dura mater (and more rarely of the other membranes) sometimes perforates the cranium and spreads rapidly underneath the scalp fungus of the dura mater). This may be distinguished from the preceding by its pulsation (which is communicated from the brain beneath), reducibility (so long as it is small), and by the sharp opening in the skull through which it protrudes. Sometimes, also, the attempt at reduction gives rise to haracteristic cerebral symptoms.

Excision is the proper treatment for both, if the diagnosis is made in time, but as a rule the disease is much too far advanced to justify an peration of such a serious nature.

DISEASES OF THE BRAIN AND MENINGES

INFLAMMATION

Inflammation may begin in the brain (cerebritis) or the membranes meningitis); or it may spread to them from structures around, the bones, he scalp, the mucous lining of the tympanum, or the eye. It may be acute, r chronic from the beginning; and it may end in resolution, or persist in milder form; or, if pyogenic organisms gain entrance, lead to diffuse or rcumscribed suppuration.

(*a*) *Simple Acute Inflammation*

Cerebritis.—Inflammation of the brain may follow the reactionary stage of concussion, or may be caused by the intense hyperæmia that attends prolonged over-excitement. It is common after severe contusions, a zone of red softening, formed partly of broken-down brain-substance, partly of inflammatory exudation, developing around the injured area; and it is always found around abscesses (with the exception of the most chronic), in acute suppurative arachnitis, and to a less extent around rapidly growing tumours. When it follows concussion or is due to over-excitement, it is diffuse and involves the whole cortex of the brain; under other circumstances it is usually local, although it may be multiple and, sometimes at least, involve a very large area.

Meningitis.—Simple acute inflammation of the dura or pia mater is rare as a *primary* affection; it may, however, occur in compound fractures of the skull, caused by septic decomposition of extravasated blood (arachnitis, for example, may start from a fissured fracture of the petrous portion of the temporal bone, laying open the cavity of the tympanum and the prolongation of the arachnoid in the internal auditory meatus), and then it nearly always ends in suppuration. On the other hand, *consecutive* meningitis, due to extension from neighbouring structures, is by no means uncommon. The infection may travel along the blood-vessels or lymphatics, by progressive thrombosis (as in orbital cellulitis and diffuse inflammation of the scalp), or by embolism (as in pyæmia); or it may spread into the membranes directly from the adjacent structures, either the bones (most of the cases of acute suppurative meningitis after compound fractures are caused in this way), or the brain. In the one case the dura mater is attacked the first, in the other the pia; but although the pathological changes, hyperæmia, softening, exudation, and extravasation, may be more marked in the one than in the other, it rarely happens that the inflammation is limited.

Morbid appearances.—In the early stages of the attack, and when the whole brain is affected, these are only slightly marked. The venous sinuses are full; the vessels of the pia and the plexuses engorged; the meshes of the arachnoid opaque and milky; the ventricles distended with turbid fluid; and the brain itself infiltrated, œdematous, and studded with minute red points like hæmorrhages. In cases of longer standing, and when the mischief is limited, the affected part appears swollen and pulpy; if it is cut across the surface rises above the surrounding level; and the colour is most conspicuous. Later still, it becomes so soft that a gentle stream of water washes it away, leaving an irregular excavation with ragged, œdematous and softened walls, breaking down at the slightest touch.

Symptoms.—The constitutional ones are merely those of acute pyrexia. There is rarely a rigor; that is the signal for pyæmia or suppuration, but the temperature rises rapidly until sometimes it attains an extraordinary height; the pulse becomes full, quick, and bounding; the respiration hurried and shallow; the bowels confined, and the appetite lost. The local ones, on the other hand, those that depend upon the organ involved, exhibit a greater variety. Headache is always present, and usually is described as agonising. At first there is general hyperæsthesia; the least noise causes intolerable suffering; the eyes cannot face the light; the pupils are contracted to pin's points; and even the skin may be exceedingly tender.

Vomiting and delirium are rarely absent; sometimes there is merely a certain amount of wandering at night, but not unfrequently there is a condition approaching that of furious mania. Then, by degrees, as the disorder of the cortex becomes greater, the abnormal state of excitement passes into a condition of insensibility; the pupils dilate; the eyes remain staring widely open; the breathing becomes stertorous; consciousness is lost, and stupor and coma set in.

The character and extent of the cerebral symptoms vary with the seat of the disease. In some cases there is weakness of the limbs on the opposite side of the body; in others there are general convulsions. Occasionally, when, for example, the inflammation spreads from a contusion in or near the motor area, the spasmodic contraction is local at the first, and gradually extends from one group of muscles to another in definite order. On the other hand, when the attack commences in the bones, as in syphilitic ostitis, and spreads from them to the dura mater, it may be some time before any symptoms that are definitely cerebral make their appearance. There is no delirium or wandering in such a case; convulsions are not present until sometimes quite late; there is no intolerance of light or sound; but there is the most acute tenderness all over the inflamed bone, especially on percussion; the pain is intense, particularly at night; and if the base of the skull is involved optic neuritis and affections of the other cranial nerves, paralysis or neuralgia, are often present. Cases of this kind, in which the inflammation is local at the beginning and remains so for some considerable time, are naturally much less severe than those in which the pia mater and the cortex of the brain are involved from the first.

The course and termination depend chiefly upon the intensity and persistence of the exciting cause.

1. Resolution may take place if the irritant is mechanical and transient, an extravasation, for example, that becomes absorbed. Every severe contusion of the brain that does not prove fatal at once is surrounded by a considerable area of red softening; and it is not uncommon for patients who have sustained injuries of this character to remain for two or three weeks in a very critical condition, feverish, exceedingly irritable, with photophobia, intense headache, quickened pulse, hot, dry skin, and often a certain degree of delirium. Then, at the end of that time, the temperature gradually falls and convalescence begins, although the least excitement or over-indulgence is sufficient to bring on a relapse.

2. Death may ensue, either because of the extent or importance of the part of the brain affected; or from exhaustion and the intensity of the fever.

3. The inflammation may become chronic if the irritant (without being pyogenic) is a persistent one. It may be a depressed plate of bone, or a foreign body driven in, or a cyst or patch of dense fibrous tissue developed from an old extravasation; or it may be a specific organism, such as that of syphilis, tubercle, or actinomycosis, sufficiently irritating to cause the production of a mass of granulation-tissue, but not, at first at any rate, lowering the vitality of the surrounding structures so far that they become unable to withstand the action of pyogenic organisms.

4. Suppuration may follow, whether other germs are present or not. If the vitality of the tissues is very feeble, or if the action of the pyogenic micro-organisms is assisted by septic decomposition and tension, it will be diffuse

and rapidly fatal. If the conditions are not so unfavourable, a limiting wall of granulation-tissue may be developed, forming a cerebral or meningeal abscess; and this, according to the rapidity with which it extends, may be acute, chronic, or even latent, remaining concealed perhaps for years. It takes, however, three weeks, or at least a fortnight, for the surrounding brain-tissue to protect itself in this way; and, consequently, circumscribed suppuration is rarely met with after compound fractures, and never until some considerable time after the receipt of the injury.

The organisms may gain access directly through a wound; or indirectly by extension along the veins (thrombosis, which is usually retrograde); by sudden embolism, as in pyæmia; or by continuity through the adjacent tissues. Whatever the way, unless everything is perfectly healthy and well nourished (when probably the germs, like those of putrefaction, are soon destroyed), they begin their work at once; the leucocytes perish and become pus-corpuscles; the plasma and formed tissues melt away; and suppuration begins, diffuse or circumscribed, according to the ability of the surrounding tissues to repel the assault.

(*b*) *Chronic Inflammation*

Chronic inflammation of the brain or its membranes may be the relic of an acute attack, resolution having been imperfect; or it may be chronic from the beginning. In either case the immediate cause is the presence of some persisting irritant, which may be mechanical, chemical, or a living organism. The inflammation may begin in the brain or the membranes; but unless a definite exciting cause, such as a depressed spiculum of bone, is known to be present, it is rarely possible to distinguish one form from the other.

Causes.—Fracture of the skull not uncommonly leaves behind it symptoms of chronic irritation of the brain, arising, certainly in many cases, from the persistence of some gross lesion. Starring of the inner table; angular depressions (smooth extensive ones, such as occur in children, are not so serious); detached spicules of bone; and even foreign bodies (fragments of knife-blades) have been known to occasion it. Intra-meningeal extravasation is more rare, but sometimes it leaves a dense, hard layer of organised blood-clot, or a cyst, pressing upon the cortex. (Subcranial hæmorrhage between the bone and the dura mater, whether occurring at birth or later, rarely gives rise to symptoms of irritation. Like smooth depressions of the cranial bones, it may cause spastic paralysis, or some form of birth palsy, if it does not of itself prove fatal; but the symptoms are nearly always referable rather to atrophy than anything else.) In other cases a dense, sclerosed condition of the bone, with nodes projecting from its inner surface, may be found; or a thickened and partially ossified plate in the dura mater; or a spot in which all the membranes are so fused with each other and with the cortex that there is nothing left but a fibrous mass with a few shrivelled or calcified ganglion-cells in its substance.

Syphilis, as it affects the membranes and the cortex of the brain more often than other parts, is a frequent cause. Osseous nodes may grow out from the inner surface of the bones (the frontal in particular, on either side of the longitudinal sinus); or gummatous deposits may occur in the dura or pia mater, or in the substance of the brain, leaving, after they have been absorbed, dense rigid cicatrices which perpetuate, or even, by their contraction, intensify the mischief already done. The coats of the arteries may be diseased, so that either the lumen is blocked and softening ensues, or their walls give way and aneurysms or hæmorrhages follow; or, again, slowly extending patches of sclerosis may develop, and by degrees involve one part after another. Tubercle, when it begins in the membranes, usually runs an acute course, and ends in a speedily fatal form of meningitis; when however, it takes the shape of a caseous mass, deeply buried in the substance of the brain, the chief symptom, until compression sets in, is the chronic irritation of all the surrounding parts. Slowly growing tumours and cysts, whether originating in the brain itself or springing from the bones, act in the same way. The persistent abuse of alcohol is said to cause the same result, leading to chronic inflammation and induration of the membranes and surface of the brain, especially on the vertex; and sometimes there are other causes, some acting directly, others giving rise to reflex irritation, and others again affecting the circulation chiefly, if not entirely, so that, *post mortem*, no local pathological lesion can be found.

The symptoms of chronic irritation of the brain, whether sufficiently severe to excite visible inflammatory changes or not, are of the most varied character. In many instances they are entirely general, without the least indication of any local lesion. A peculiar condition of general irritability, for example, is often left after severe contusions. Recovery does not appear to be complete; there is a great tendency to headache, especially after any mental exertion or excitement; the patient is irritable, giving way to fits of passion without any apparent reason; memory is defective, sometimes generally, sometimes only for certain special things; the power of mental concentration is impaired, and the patient is quite unable to do what he used to do without effort before. It seems as if the circulation through the brain does not easily regain its power of self-control; for a long time the least mental excitement or over-exertion is enough to throw it into disorder, and to bring back, temporarily, the condition of hyperæmia and congestion that followed immediately upon the receipt of the injury. As a rule this passes off; but sometimes, if the part is not kept at rest, it becomes permanent, and a lasting condition of cerebral incapacity is left.

The symptoms are the same when the irritant is a persistent one, but they are usually more intense. Headache is never absent, sometimes it is general, sometimes local; but wherever it is, it is always made worse by excitement, or by hanging the head down, or by the use of alcoholic stimulants. Vomiting, such as is met with in cerebral affections, apparently purposeless in character, is not infrequent. Vertigo may occur, especially on suddenly rising up. Optic neuritis is nearly always present, especially when the membranes at the base are concerned; and in many cases there are other affections—neuralgia, for example, or paralysis of the other cranial nerves.

Some form of mental disturbance is rarely absent. It may be merely irritability and wakefulness, with an uncertain temper; or there may be loss of memory and power of concentration with want of mental vigour, and in extreme cases dementia. The local symptoms are no less variable. Spasmodic convulsions may occur if the irritant affects the motor portion of the cortex, and without occasioning any loss of consciousness, may spread from one centre to another. Traumatic epilepsy may follow, the discharging lesion from constant repetition becoming permanent. Or paralysis may occur, but this is less frequent, as lesions that cause chronic irritation or inflammation are usually connected with the membranes or the surface of the brain, and slow destruction of the cortical motor centres in one hemisphere admits very largely of compensation.

Valuable information, both as to the site and nature of the lesion, may frequently be obtained in other ways. In traumatic cases, for instance, there may be a depression or irregularity on the surface of the skull. Pressure may be exceedingly painful at one particular spot; or the whole bone may be tender on percussion. The pain may be altogether of a different character, dull and heavy, infinitely worse at night, due chiefly to the ostitis. The temperature of the part may be higher than that of the corresponding point. The skin may be puffy or raised; or there may be evidence of obstruction to, or pressure upon, structures passing out through canals in the bone; and these symptoms of course vary in every case.

SUPPURATION

Acute inflammation of the brain and its membranes may terminate in suppuration. The pus may form between the bone and the dura mater (subcranial), probably always extending inwards from the bone; between the meninges (subdural); or in the substance of the brain. In this last situation the abscess may be separated from the external focus of disease from which it started by a layer of healthy brain-tissue, and even by intact and unaffected membranes, the infection having travelled inwards along one of the veins or in its perivascular sheath.

Suppuration is limited or not, according to the relative vigour of the tissues on the one hand and the irritants on the other. If the latter are much the stronger, it will be *diffuse* and set in acutely; if the difference is not so great, it may be *circumscribed*, two or three weeks being required for the development of the limiting wall of granulation-tissue; and if the balance is only just in their favour, it may be *chronic* and even latent, remaining concealed perhaps for some years.

Cause.—Intracranial suppuration may originate in three different ways.

(1) It may break out *after contusion or concussion of the brain*, even though the skin has not been injured or the bone fractured, the pyogenic organisms being carried by the blood, but not causing embolism. Fortunately it is very rare. It may be either diffuse, acute cerebritis running on to suppuration, and proving fatal within a few days, or circumscribed, the area of red softening round the contusion gradually growing more and more liquid in the centre until it simply becomes a collection of pus. Abscesses caused in this way are nearly always single and in the substance of the brain. Not unfrequently they are situated on the side opposite to the injury—in the right frontal or temporo-sphenoidal lobes, for example, when the blow has fallen upon the left side of the occiput, owing to the fact that in such cases this is the part of the brain that usually suffers most.

(2) It may be due to *pyæmia* consequent upon the impaction of pyogenic emboli from some distant focus of suppuration (usually in the lungs). If it occurs in connection with the membranes it is always diffuse; if it is in the brain it is nearly always multiple and generally in the course of the middle cerebral artery.

(3) It may be due to *extension from suppuration near*. This, which is by far the most common and the most important variety, may be the result either of injury or disease.

(*a*) *After injury.*—Acute suppurative meningitis may be caused either by the organisms entering through the wound directly, or by extension inwards as a result of suppuration in the diploë.

In the former case the inflammation breaks out within a day or two after the injury. It usually occurs after small punctured fractures, not when the bone has been extensively comminuted and all the loose fragments have been removed. In these cases a considerable amount of blood is often extravasated; it collects in the wound, exposed to the air, and so long as the fragments remain impacted is unable to escape. If septic decomposition is allowed to take place, the products soak into the bruised and damaged tissues around, and lower their vitality to such an extent that suppuration follows at once, and is always diffuse. The meshes of the pia mater are filled with exudation, which surrounds the veins, dips into the sulci, and covers the convolutions, until it can be stripped off like a cast of yellowish green wax, bringing with it the surface of the softened and infiltrated cortex.

In the latter case, when the meningitis is secondary to acute suppurative ostitis, the appearances and the result are generally the same, although it may be several days before the disease is so far advanced. Sometimes, however, when the dura mater is not torn, the course is more protracted, and subcranial (extradural) suppuration occurs, and persists for some little time before the inflammation gains the subdural space and becomes diffuse; and, occasionally, even when the dura mater has been punctured and spicules of bone driven into the substance of the brain, there is no definite evidence of the formation of pus, though weeks may have passed since the receipt of the injury. Probably in this latter case there has been no septic decomposition, and the pyogenic organisms, with only a limited area of damaged tissue at the seat of injury, without the assistance of the poisonous products of putrefaction, have only been able to cause the minimum of destruction.

In exceptional instances intracranial suppuration may follow a simple contusion of the cranial bones, suppurative ostitis breaking out at the seat of injury and extending inwards. A severe blow is received upon the head; blood is extravasated into the veins of the diploë and under the pericranium; usually it becomes absorbed; occasionally days or weeks after the injury suppuration breaks out, the organisms having entered from some already existing focus of suppuration, through a wound, or through the mucous membranes. At once the inflammation becomes much more severe; the pericranium is detached from the bone on one side and the dura mater on the other; the exudation pours out into all the tissues around, lifting up the skin (Pott's puffy tumour) and glueing together the membranes; acute osteophlebitis sets in, and the pus spreads rapidly through the softened and inflamed tissues. Suppurative ostitis of this character is so often associated with pyæmia, sometimes as its cause, that when the pus does burst through the bone it rarely remains limited; nearly always, however early an incision is made, the pericranium is already stripped up, the bone is bare, rough, and brown, and if a trephine is applied, pus wells out from the groove mixed with the bone-dust. When the disc is lifted out, instead of a circumscribed abscess, the dura mater is already perforated and the arachnoid and subarachnoid spaces are filled with a thick layer of yellowish-green pus.

(*b*) *As a result of disease.*—Intracranial suppuration is frequently caused by extension inwards from a purulent focus in the surrounding tissues, with out fracture or other injury. The pathological process is essentially the same as when it follows an open wound or a compound fracture; the route, that is to say, may be direct, the micro-organisms simply invading one part after another and forming a continuous track of suppuration; or the inflammation may spread along the veins or lymphatics without leaving in the intervening tissues any evidence of its passage through them; but the difficulty of localisation is so great, and the onset of the disease in the majority of cases so insidious, that a separate description is advisable.

As in the case of compound fractures, the suppuration may be either *diffuse*, involving the membranes, or *circumscribed*, and usually in the substance of the brain (cerebral abscess); but the relative frequency of the two is very different.

The former, which is by far the most common after injury, is rarely met with unless there is acute extra-cranial inflammation, such as orbital cellulitis, facial carbuncle, diffuse inflammation of the cellular tissue of the scalp, the so-called phlegmonous erysipelas, or acute suppuration in connection with the ear. In all probability the infection extends along the veins or their sheaths, the ophthalmic for example, or the mastoid, or those that pass back through the sphenoidal fissure, for the meningitis is nearly always associated with thrombosis of the sinuses and general pyæmia. So far as the pathological appearances are concerned, it does not differ in any material respect from the diffuse suppurative meningitis that occurs after compound fractures.

The latter (*cerebral abscess*) results almost always from chronic suppurative disease, and is usually consecutive to caries of the ethmoid, or especially the petrous portion of the temporal bone.

Catarrhal inflammation of the middle ear is exceedingly common after the exanthemata (particularly scarlatina and measles), and may occur whenever the mucous membrane of the throat becomes inflamed. In most cases it subsides without any ill consequence; but if it runs on to suppuration it may lead to perforation of the membrana tympani and destruction of the auditory ossicles; or it may become chronic, spread from the mucous membrane to the periosteum and the bone beneath, and give rise to caries and necrosis. When this takes place there is always imminent danger that it may extend farther still.

Extension may take place while the inflammation is acute, or later when it has become chronic, and there is nothing to attract attention but the loss of hearing and a little purulent discharge from time to time. In the former case, as in traumatic intracranial suppuration, it is usually diffuse;—if the conditions are so favourable that the pyogenic germs can spread without difficulty through the petrous portion of the temporal bone to the meninges, they are not likely to remain localised and confined there. In the latter case it is nearly always circumscribed. So long as the exit is free and the discharge is not allowed to accumulate and decompose, the danger is not great, although suppuration does sometimes occur even under these conditions, the abscess remaining latent in the brain. If, however, the outlet becomes blocked, whether this is due to dried-up discharge or to the growth of polypoid granulations, the pus that is retained begins to decompose the tension becomes higher and higher, and extension of the inflammation is the natural consequence. It depends chiefly upon the accidental anatomical relations of the focus of disease, whether the pyogenic organisms spread to the dura mater (causing subcranial abscess or diffuse meningitis), to the brain (finding a route by direct continuity of structure, or along the veins or lymphatics), or to the blood vessels in the diploë, giving rise to osteophlebitis, thrombosis of the lateral sinus, or pyæmia.

These relations, and particularly the development of the mastoid cells, vary at different periods of life. In a child two years of age, there is only a small air space lying immediately behind the tympanum; the cells that occupy the mastoid process have as yet no existence, and the lamina of bone which forms the roof of the tympanum and helps to separate the external meatus from the middle fossa is exceedingly thin. On the other hand, in adults, the mastoid process may be excavated by great hollows quite up to the lateral sinus and the mastoid vein (especially when the sinus curves rather more forward than usual, for its position is very variable). Suppuration therefore in connection with the mastoid cells would tend to spread more easily towards the middle fossa in the child, towards the sinus in the adult; but further evidence is wanted to establish this as a fact.

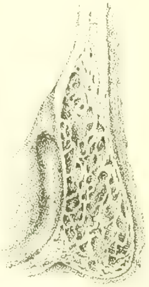


Fig. 276.—Section (slightly oblique) through the mastoid process and the lateral sinus, showing the relation they bear to each other in the adult.

In many cases, the inflammation spreads by direct continuity of structure: the bone becomes inflamed, and necroses; the dura mater over it sloughs, and either the pus spreads into and through the arachnoid space at once, or the membranes become glued to each other and to the cortex by inflammatory exudation before this can occur. There are, however, many other routes almost as direct, along which the infection may travel. It may spread, for example, down the internal auditory meatus, or through the hiatus Fallopii, or the aqueductus vestibuli, or it may extend along some of the numerous small veins (each surrounded by a perivascular lymph-sheath) which run between the internal and middle ear on the one hand and the dura and pia mater on the other. Some of these pass directly from the temporo-sphenoidal lobe of the brain to the dura mater covering the petrous portion of the temporal bone; others run through the squamo-petrosal suture, and through the slit for the dura mater that lies by the side of the aqueductus vestibuli; others, again, lie in some small canals (immediately behind the superior semicircular canal) which connect the middle ear directly with the middle fossa of the skull; and not a few communicate with the middle meningeal veins and the superior petrosal and lateral sinuses.

In most cases of disease of the middle ear the abscess is in the temporo-sphenoidal lobe; sometimes the dura mater covering the anterior surface of the petrous portion is unaffected; generally it is sloughing, or at least inflamed. The abscess is usually of large size (an inch and a half or two inches in diameter); its walls may be very thick (occasionally acute suppuration develops round an old encysted abscess); and it may lie in the substance of the lobe, covered over by a layer of apparently healthy cortex a quarter of an inch in thickness, or communicate with the suppurating focus in the bone through a sinuous channel. The pus is generally exceedingly fœtid. The abscess if left to itself may remain latent for years; or acute symptoms may suddenly develop from some comparatively trivial cause, exposure to cold for example, or a blow upon the ear: usually it terminates sooner or later by rupturing into the lateral ventricle or the subarachnoid space.

Cerebellar abscess is less frequently met with. There is a certain amount of evidence that it is more common, comparatively, in children than in adults and when the mastoid cells are inflamed. Thrombosis of the lateral sinus is associated with it in many instances.

Abscesses in other localities are more rare: but they are sometimes found between the dura mater and the bone (extra-dural); in the centrum ovale; even on the opposite side of the head (probably pyæmic, or at least thrombotic); and in the pons. It is said that the last is consecutive to disease of the internal rather than of the middle ear.

In comparison with this, intracranial suppuration consequent on disease of bone elsewhere, is seldom met with. Both forms, however, the diffuse and the circumscribed, may occur in the region of the frontal lobes from caries of the ethmoid and ozæna; and one or two instances are recorded in which the same thing has happened in connection with the orbit.

Symptoms.—1. *Diffuse suppuration.*—It is rarely possible to tell when suppuration begins in a case of acute inflammation of the brain. Sometimes there is a rigor, but it is by no means invariable, and if it does occur it more frequently indicates the commencement of pyæmia. The constitutional symptoms simply grow more and more severe, the temperature in particular rising to an exceptional height, while the local ones gradually merge into those of compression. The cortex becomes more and more disordered; convulsions, excitement, and delirium give way to paralysis, loss of consciousness, and coma; the pupils dilate; the eyes remain widely open; the face becomes flushed and dusky; the pulse slow and full; and respiration laboured and stertorous.

2. *Intracranial abscess.*—The symptoms depend upon the rapidity with which it is formed, the rate at which it extends and the locality in which it occurs. In rare instances intracranial abscesses are acute, ushered in with a rigor and high fever. Much more often they are chronic and even latent, without any elevation of temperature; sometimes there is an actual fall, so that, for a time at least, it is subnormal. Occasionally, after existing without a symptom for an indefinite period, an abscess suddenly becomes acute, spreads rapidly, and breaks into the ventricular or subarachnoid space. The local symptoms are those of pressure upon or irritation of the structures that lie around it.

The most important varieties are the traumatic and that which is secondary to disease of the middle ear. Others are more rare and seldom admit of diagnosis.

(*a*) *Traumatic intracranial abscess.*—The symptoms are partly general, indicative of disturbance of the whole nervous system; partly local, arising from affections of special portions of the brain, or the nerves, or the bones and membranes covering them in.

There is always a latent period after the accident, at least a fortnight, generally much longer, sometimes years. At the time there may have been concussion, or evidence of contusion of the brain; but in a typical example this has passed away. Recovery, however, is not perfect: the patient grows thinner, or loses his memory: perhaps he becomes irritable, or there is general failure of power, bodily as well as mental. Sometimes these signs are so marked that the friends notice them and become anxious: sometimes they are scarcely perceptible. The temperature is usually subnormal, although slight chills may occur, the pulse is quick and irritable at first, very slow towards the end. Pain is rarely absent: in most cases it is very severe; usually it is general, affecting the whole head; sometimes it is local, and associated with great tenderness on pressure or percussion. Optic neuritis is present in nearly every case, and irregularity of the pupils is often noted, the one that is more dilated and fixed corresponding to the affected side. Very often local signs are entirely wanting; there is merely headache followed by drowsiness, paralysis, and at length coma, without its being possible to say from the brain-symptoms more than that it is a case of gradual compression.

Valuable information is often gained from the condition of the skin or the bone. Sometimes there is a scar or an irregularity on the surface of the cranium from depression of a portion of bone. In many instances there has been a history of purulent discharge following fracture, and of very protracted healing. Occasionally the discharge has stopped, collected, and begun again more than once before the symptoms became serious, although each time there may have been a certain degree of headache and feverishness. Tenderness on percussion over the affected bone is not uncommon. Sometimes there is a dull, aching pain, especially severe at night. In a few cases there is a soft puffy swelling on the scalp, due to effusion under the pericranium (Pott's puffy tumour), and pointing to commencing suppuration in the diploë.

Intense neuralgia in all the three branches of the fifth pair has been noted once or twice. Paresis from pressure, occasionally passing into paralysis, is more common, affecting especially the motor nerves of the eyeball.

Cerebral symptoms, monospasm and monoplegia, gradually extending over a wider area, are rare. They only occur when the motor area is involved, and are not always present then. When cerebral abscess is caused by *contre-coup* they are the only local signs that are present.

Diagnosis.—*Diffuse suppurative meningitis* usually runs a much more rapid course: it begins within a short time of the injury, almost always in the first week, sometimes in forty-eight hours, and is associated with high fever, headache, delirium, and other signs of rapidly-spreading destruction of the cortex.

Chronic meningitis is often present as a complication in cerebral abscess; by itself it does not give rise to symptoms of compression.

Pyæmia is the most difficult, especially when it commences as osteophlebitis in the injured portion of the cranium. The difference is merely in the method of extension. Each commences, in many cases at any rate, as a purulent ostitis, with a soft, puffy, and exceedingly tender swelling upon the scalp. In the one, the suppuration spreads through the contiguous structures to the membranes and the brain beneath, until an abscess is formed. In the other, the veins of the diploë and the sinuses are thrombosed, and infective emboli carried off to cause abscesses elsewhere. The local signs are the same: the early constitutional ones present no material difference; a single rigor may occur in either; indeed, it is not until pyæmia has shown its presence by local indications in other parts of the body, or by repeated shivering fits, that the diagnosis is certain. The difficulty is not so great when cerebral abscesses are dependent upon other causes than disease of bone, but then, not unfrequently, all but the most general symptoms are wanting altogether.

(*b*) *Intracranial abscess due to disease of the middle or internal ear.*—Nearly three-fourths of these are situated in the temporo-sphenoidal lobe, and many are associated with a sloughing condition of the dura mater. The rest occur in the cerebellum, between the dura and the bone, in the pons, and occasionally in distant parts of the brain. They never appear while the inflammation is acute; there is always a history of chronic purulent discharge lasting for years, and often of its having stopped on some previous occasion which was marked by severe headache, vomiting, and perhaps other symptoms.

In most instances two stages can be distinguished: the first, while the abscess is slowly forming, of very indefinite length; the second, that of rapid extension, rarely lasting more than a week. The transition may be gradual, but more often it is sudden, caused by some comparatively trivial accident, such as a blow upon the ear or exposure to cold and wet. Many apparently unaccountable cases of fatal coma are explained in this way: an old cerebral abscess, which has already lasted weeks or months without giving rise to any definite symptoms, suddenly giving way and bursting into the ventricular or subarachnoid space.

The symptoms in the early stage are vague and ill-defined. There is always headache, sometimes very severe, and, not unfrequently, vomiting without any apparent reason, as is usual in cerebral affections; but in many, the only sign is a dull, sluggish, state of mind, sometimes uniformly lethargic, sometimes, on the other hand, diversified by strange fits of irritability, and, in rare cases, delirium and convulsions. Rigors, pyrexia, and optic neuritis seldom occur.

In the acute stage, the symptoms present the same general characters, but they are infinitely more severe. The headache is of the most intense description, radiating from the ear and causing such fearful agony that the patient can do nothing but scream or rock himself from side to side, clasping his head in his hands or burying it in the pillow. The lethargy rapidly deepens into stupor; there may be an attack of vomiting or a single rigor, but this is more commonly associated with subdural abscess and thrombosis of the lateral sinus; the face becomes dark and cyanosed, the respiration laboured and stertorous, and coma, with or without convulsions, quickly follows. Death usually takes place within the week, sometimes within a few hours.

Diagnosis.—An accumulation of decomposing *pus, pent up in the mastoid antrum*, may cause many of the symptoms of cerebral abscess, including, according to Barker, double optic neuritis. In any case of doubt a preliminary exploration should be made, a trephine or gouge applied to the outer wall half an inch behind and above the centre of the external meatus, the cavity thoroughly opened and washed out. This difficulty of course only occurs in the early period of the disease, before there are any symptoms of compression.

Thrombosis of the lateral sinus.—According to Pitt, this is usually due to direct extension from the bone on the posterior surface of the petrous part; more rarely from the mastoid cells and along the vein of the cochlea. The clotting may be local or extend into the other sinuses and down into the jugular vein. When due to ostitis it nearly always proves fatal from pyæmia. The symptoms resemble to some extent those of cerebral abscess, but there is usually a rigor, or at least a very irregular temperature; the pain is more local; there is a tendency to retract the head; the neck is stiff; and occasionally subcutaneous œdema may be noted over the mastoid, or the internal jugular vein can be felt as a hardened cord in the neck. Optic neuritis, vomiting, headache, giddiness and even coma may be present in these cases before any clearly pyæmic symptoms make their appearance. Hitherto these cases have been regarded as practically hopeless: it has however been shown by Ballance and others that recovery is possible even after pyæmic symptoms have made their appearance in distant parts of the body, if only the disease is treated thoroughly. The mastoid antrum must be cleared out first: if nothing is found in it to account for the symptoms; or if, in spite of this having been done, the pyrexia and irregular temperature continue, the orifice of the mastoid vein (an inch and a quarter behind the meatus) should be exposed, and if it is thrombosed a further operation undertaken. The jugular vein must be ligatured in the neck; the whole of the dead bone between the meatus and the wall of the lateral sinus cut away, so that there may be free exit for the pus that lies between the membranes and the bone; and the cavity that is left, the sinus itself, and the upper part of the vein thoroughly syringed out with a solution of corrosive sublimate.

Subdural abscess may form on the posterior surface of the petrous portion of the temporal bone, or over the roof of the tympanum close to the squamoso-petrosal suture. In the former locality it is nearly always associated with thrombosis of the lateral sinus, the pus spreading between the dura mater and the bone until it reaches the fibrous wall and so alters the endothelium that a clot forms upon it. In the latter it may occur independently by itself. It is very doubtful, when it exists by itself, whether it can be distinguished from cerebral abscess; rigors appear to be more common; percussion over the temporal bone is more painful and the cerebral symptoms are less distinct; but the two may be associated together. The diagnosis is not perhaps of so much importance, as in any case in which the symptoms continued after the mastoid cells had been cleared exploration must be continued in the same direction: behind the mastoid process if there is any evidence of sinus thrombosis, above and slightly in front (so as to expose the anterior surface of the petrous part) if there is not.

The diagnosis of the locality of cerebral abscess, when consecutive to ostitis, is equally difficult. The majority are situated in the temporo-sphenoidal lobe, especially in the case of adults; of the rest, most are in the lateral lobe of the cerebellum, the others are practically inaccessible.

An abscess in the temporo-sphenoidal lobe does not cause any localising symptoms until it has attained a very considerable size. As it increases, the third nerve on the same side becomes compressed, so that ptosis, fixed mydriasis and paresis of the ocular muscles ensue; and then the lower part of the ascending frontal and parietal convolutions, so that the facial muscles on the opposite side of the body become paralysed (retaining however some power of emotional expression), and then, later, those of the arm. The leg is never affected; and sensibility remains unimpaired.

Cerebellar abscess is still more indefinite. It appears to be relatively more common in the young, and there is no doubt that it is often associated with thrombosis of the lateral sinus. Severe occipital pain, persistent vomiting, and retraction of the head are suggestive of its presence; but unless there is definite evidence of disease of the posterior surface of the petrous portion, exploration for cerebellar abscess should never be made until the existence of a temporo-sphenoidal one has been excluded.

Prognosis.—Intra-cranial suppuration, whether traumatic or consecutive, if left to itself is practically hopeless. A few cases have recovered, the former by the cicatrix giving way so that the pus was discharged externally, the latter owing to the abscess becoming surrounded by a dense capsule; but the number is very small. Death may be caused by compression, or by the abscess rupturing suddenly into the ventricles. Occasionally a condition of marasmus sets in and proves fatal without any definite reason; and sometimes sudden death occurs, as in the case of cerebral tumours.

General treatment of inflammation of the brain.—**1.** *Preventive.*—If there is a wound no effort should be spared to free the surface from all possible sources of irritation, whether mechanical, such as depressed fragments of bone, or chemical, such as the products of decomposition; and to secure perfect drainage, so that there may be no retention of lymph and no tension. In the same way, if there is suppuration in connection with the middle ear, and the membrana tympani is bulged outwards by a quantity of opaque white pus, it should be incised from top to bottom behind the malleus, and transversely below it, and the cavity thoroughly drained. Still more is this necessary if the disease has already involved the bone, so that a foul collection of decomposing pus lies buried behind the meatus.

If there is no wound, but merely a history of a severe blow upon the head, followed perhaps by symptoms of concussion or contusion of the brain, absolute rest must be enforced. Everything that causes hyperæmia of the brain—mental exertion, excitement, want of rest, stimulants, even conversation—is injurious, and tends to delay recovery. The head should be shaved, cold applied, the room darkened, the bowels thoroughly opened (preferably with calomel) and only the lightest diet allowed; nor should any precaution be omitted until a sufficient time has elapsed for the extravasated blood to become absorbed and the damaged tissue repaired. In other parts of the body this often takes a fortnight or three weeks: and there is no proof that a shorter time is required in the case of the brain.

2. *Curative.*—(*a*) *Acute inflammation.*—If, in spite of this, the symptoms of acute inflammation, the headache, pyrexia and delirium, grow worse, leeches may be applied behind the ears; venesection may be tried; the calomel may be repeated so as to produce copious evacuation, and if there is great excitement, small doses of opium, or, better, bromide of potassium and chloral may be given; but if the inflammation is general, if no local cause can be found and removed, there is very little hope; it is almost sure to run on to diffuse suppuration.

(*b*) *Chronic inflammation.*—The treatment depends upon whether a local cause can be found or not. If there is a tender spot on the bone corresponding to an old injury, or a depression, or a suspicion of some alteration on the inner surface, such as splintering of the inner table, thickening of the dura mater, or the formation of a cyst in the arachnoid, the cicatrix should be reopened, the periosteum reflected, and a circle of bone removed with the trephine. If nothing is found to account for the symptoms, the dura mater should be examined too and incised; and if the brain projects upwards into the wound, indicating a certain amount of pressure, it should be explored with a grooved needle or a fine trocar and cannula. Possibly there may be a chronic abscess or a cyst. If nothing is discovered, the dura mater should be readjusted, sutured or not, according to the size of the opening, and the bone, provided it is not thickened or sclerosed, replaced again.

Where there are no local symptoms, but merely, instead of perfect convalescence, a condition of irritability, excitement, or headache, great relief may be obtained by counter-irritation, blisters, and even setons. Mercury pushed to salivation has been strongly recommended; iodide of potash is also said to have been of service; but probably most reliance must be placed upon the effect of time and perfect rest. Change of air and scene, and the avoidance of everything that can cause cerebral hyperæmia, naturally suggest themselves, and, of course, special attention should be paid to the presence of any diathesis, such as syphilis or gout.

(c) *Intracranial suppuration* can only be treated by operation. The diffuse form in which the whole surface of one hemisphere is covered over with a layer of pus, dipping down into the sulci and sheathing all the vessels, is practically beyond reach. The localised one requires trephining.

In traumatic cases there can be no question. Except in those rare instances in which the abscess has developed as a result of *contre-coup* (and they rarely admit of diagnosis), an exploratory operation should be performed at the seat of injury; and when the brain is exposed, if the cause still remains undiscovered, a grooved needle should be thrust into it in all directions. Many cases have been relieved in this way, some temporarily, the immediate symptoms of compression passing away, so that the patient recovered consciousness and the pulse regained its vigour (I have, on several occasions, seen all the vessels in the scalp begin to spirt as soon as the tension was relieved); others permanently, recovery having been complete.

The same thing holds good with regard to cases that are *consecutive to middle ear disease*, but the difficulty is much greater. Other affections, especially thrombosis of the lateral sinus and pyæmia, are caused in the same way and give rise to very much the same symptoms; and even when these are excluded there is often no definite evidence as to locality. In all such, the mastoid antrum should be thoroughly explored first, and a free communication established between it and the external auditory meatus; in many instances, relief is obtained at once by this, the incipient meningitis, which is probably the cause of the cerebral symptoms, subsiding as soon as the cause is removed. If this does not succeed, or if no evidence of accumulated pus is found, the exploration must be carried farther. Whether it should be made half an inch above and slightly in front of the meatus, so as to expose the anterior surface of the petrous portion, or behind and on the same level, must be guided by what is known of the condition of the sinus. In either case, the exit must be as free as possible, not only for the pus in the brain, but for all the gangrenous shreds of dura mater.

In all cases the orifice of the mastoid vein must be exposed first. If this gives no evidence of thrombosis, and there is no other sign, the anterior operation should be selected, the under surface of the temporo-sphenoidal lobe exposed, and, if there is no extradural collection of pus, thoroughly explored with a grooved needle. If, on the other hand, there is any symptom pointing to the sinus, the bone should be removed from behind the meatus; and if an extradural abscess and septic thrombosis are found, the jugular vein should be ligatured too. The only hope lies in thoroughly clearing out the clot and removing the whole focus of disease.

If no abscess is found in the anterior operation, either between the dura mater and the bone, or in the substance of the brain, and there is no evidence of thrombosis, even when the mastoid vein is exposed, the periosteum and the muscular attachments must be separated from the occipital bone beneath the superior curved line, and the lateral lobe of the cerebellum explored. In many cases of cerebellar abscess, however, there is sinus thrombosis as well, and there must always be considerable danger of one of the two being overlooked if the other is found.

Hernia Cerebri

Hernia cerebri is a protrusion through an opening in the cranium of brain substance that has been softened by inflammation; and it is caused by the difference between the external and the internal pressure.

When a portion of the brain is excised the cavity fills almost at once, and the edges of the incision become everted. If the scalp is laid down again, and union takes place by the first intention (protection being afforded in the meantime by the dressings), the outside tension is restored and there is merely a slight sinking inwards, corresponding to the amount of tissue removed. (Sometimes, when, for example, the loss has been very great, and the walls cannot fall in, a serous cyst forms to fill up). If, on the other hand, inflammation sets in instead of repair, the brain tissue becomes softened, the intracranial tension rises higher and higher, and either symptoms of compression follow, or the pulpy brain substance is squeezed out through the opening.

The defect in the cranial walls may be caused by injury (compound fractures wounding the membranes); or by necrosis, syphilitic or otherwise, causing gradual softening of the dura mater.

The inflammation of the brain may be produced by any of the causes already mentioned (the area of red softening, for example, that exists round a rapidly growing tumour might lead to the development of a hernia after excision); but inasmuch as nearly all the cases of inflammation that coexist with an opening in the cranium are due to decomposition of the extravasated blood and end in suppuration, hernia cerebri is almost always regarded as the product of suppurative meningitis. The protrusion, in cases of injury, consists at first of extravasated blood mixed with inflammatory exudation; later, of the latter with a varying proportion of softened and broken-down brain tissue. In cases of necrosis the first layer naturally is wanting.

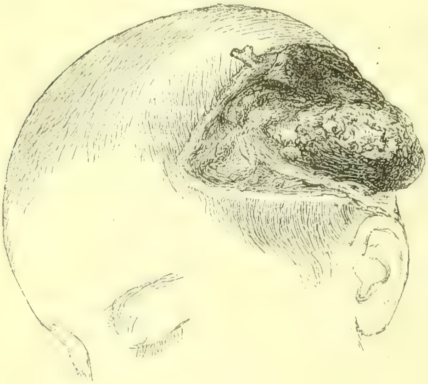


Fig. 277.—Hernia cerebri.

As the tension increases and the process of softening extends, more and more of the underlying brain tissue is forced out, until sometimes, if the

It is more frequent in the young than in the old; in the frontal than in the parietal region; and it is more likely to occur when the opening is small than when the cranial bones are extensively comminuted. The appearance is unmistakable. There is a soft, dark brown mass, covered over with lymph or pus, bleeding at the slightest touch, and pulsating synchronously with the brain. It may grow rapidly, becoming more and more œdematous as it protrudes from a narrow opening, or the increase may be very slow; and after a time it may cease altogether, shrink back of itself, and skin over. Recovery may take place even after large masses have sloughed away, the space left in the cranium being filled with clear serous fluid; more frequently the meningitis proves fatal.

Hernia cerebri is always the result of inflammation; if this is local and circumscribed, and the products can escape freely, the hernia gradually sinks back and skins over; if it is diffuse, nothing is of much avail. An ice-bag must be laid upon the head, and the ordinary treatment adopted for inflammation of the brain. The protrusion itself must be kept perfectly clean; it is no use either applying pressure or shaving it off. The prognosis depends upon the inflammation.

Intracranial Tumours

In 1884, relying entirely upon the clinical evidence of a focal lesion, Godlee exposed the surface of the brain and removed a tumour from beneath the cortex. Since then the same operation has been performed on many occasions by MacEwen, Horsley, and others, with very considerable success. Unhappily the conditions are so stringent that the proportion of cases in which relief by operation is possible is very small. Localisation must be exact; the site must be accessible; the size of the tumour must not be too great, or the lesion left may be practically as bad; and there must be no other growth or disease. Success is naturally more probable when the tumour is surrounded by a capsule than when it is of an infiltrating nature, but this it is rarely possible to determine beforehand.

The tumours that are grouped together under this class may grow from the bones, the membranes or the brain. Some are primary, others secondary, the original lesion occurring elsewhere.

(*a*) *In connection with the bones.*—Tumours (other than syphilitic or inflammatory outgrowths) springing from the inner surface of the inner table of the skull are very rare. Myeloid sarcoma is not uncommon in the diploe, and ivory exostoses may grow from the frontal or other sinuses; and both of these may cause a very serious inward projection of the bone; but they usually admit of speedy recognition from the exterior, and in any case require to be dealt with on their own merits.

(*b*) *In connection with the membranes.*—Fibromata have been described in connection with the dura mater. Sarcomata are rather more common, sometimes causing absorption of the bone lying over them (the so-called fungus of the dura mater), and seriously compressing, but not invading, the brain beneath. Cysts, possibly originating in old extravasations, are met with from time to time in the arachnoid cavity, sometimes free, sometimes attached; hydatids have been known to occur; and occasionally other tumours, plexiform angeiosarcoma or endothelioma (in which the walls of the vessels appear as if they were converted into sarcoma tissue), psammoma, cholesteatoma, &c., of little clinical importance.

(*c*) *In the brain.*—Three-fourths of the tumours that occur in the substance of the brain are either gummata or caseous masses of tuberculous material. The former, which nearly always occur in connection with the membranes or the vessels as they dip through the cortex, are very irregular in shape and size, and usually present on section a surface marked by spots of caseation separated from each other by firmer tracts of fibrous tissue. So long as they are spreading, the surrounding brain-tissue is softened and hyperæmic; after absorption there is merely a dense, indurated, star-like cicatrix, tying the brain down to the membranes, and spreading in its substance in all directions.

Tubercular masses, on the other hand, are usually rounded and uniform in shape, and opaque and cheesy on section. Around them, so long as they are spreading (and they may attain the size of a pigeon's egg) is a zone of grey granulations, spreading along the vessels; later they may soften and form a caseous abscess, or develop into fibrous tissue, or dry up and undergo calcification. Naturally they are more common in the young, while gummata are generally met with in adult life. In many cases they are multiple (more than half according to Gowers), and not unfrequently are associated with tubercular disease of the membranes and other organs.

Gliomata are the next most common. They are composed of tissue resembling to some extent the neuroglia of the brain, but they vary very much in consistence, and the softer ones are often stained with old and recent extravasations. They differ from the former and from other kinds of sarcomata in their infiltrating character, spreading among the nerve elements without any defined outline.

Other forms of sarcoma are more rare. Carcinoma has been described as a primary affection in the brain, and occasionally other tumours and deposits of actinomycosis.

Dermoid cysts have been known to occur, sometimes projecting on the exterior of the cranium through the bone. Hydatids and cysticerci are occasionally found both in connection with the membranes and the brain. Most of the serous cysts that have been described have originated in all probability either in the interior of sarcomata or in connection with old injuries and extravasations.

Symptoms.—Some of these are general, occurring more or less with all tumours, whatever position they occupy inside the cranium; others are localising and are only present when certain parts are involved.

(*a*) Headache, due in great measure to the tension upon the fibrous structures; vomiting, apparently without cause or object, and especially on waking; vertigo on suddenly rising up; optic neuritis; mental dulness and lethargy, are the most prominent and the most constant among the former. For a full account, special works, such as those by Gowers and Bramwell, must be consulted.

(*b*) These may be due to interference with the cortex, the conducting paths, the nerves, or the walls. The more rapid the growth and the greater the amount of irritation and inflammation it causes in the tissues around it, the more distinct they are.

Lesions of the cortex may lead to perversion or abolition of its function. If the part involved is motor there may be localised epileptiform convulsions (the most valuable sign of all), followed by loss of power in the muscles most concerned, without any loss of consciousness. Nearly always this is due to some coarse lesion, and most often a tumour. Greater pressure causes paralysis at once, extending in a definite order. When the part is not a motor one, the indications are much less distinct; but as mind-blindness has been caused by a spicule of bone driven into the angular gyrus and has been cured by its removal, it is possible that similar evidence may be obtained of the growth of a tumour. The presence of a visual aura at the same time would render this much more probable.

Lesions of the conducting paths are attended in the same way by abolition or perversion of function; but in this case the former (manifested as paralysis or anæsthesia, according to the part involved, without any sign of irritation) is much the more prominent. If the internal capsule is concerned there may be hemianæsthesia or hemiplegia; if the lesion is lower, mixed or irregular forms, the muscles that are paralysed on the same side as the lesion becoming atrophied and exhibiting the reactions of degeneration. If the paralysis is incomplete, and particularly if it is variable, there may be only pressure on the fibres without destruction; but unless this can be clearly proved to be the case it is very improbable that the lesion is within reach, or, if it is, that it is not too large.

Pressure upon the cranial nerves is often of great value in localisation; neuralgia of all the branches of the fifth pair upon one side, for example, or anæsthesia limited to the same region, pointing definitely to intracranial pressure upon the trunk before its division.

Affections of the walls have been already mentioned; they are rarely present when the growth originates in the brain, until, that is to say, it has attained a size that precludes interference.

Diagnosis.—Bright's disease and advanced forms of lead-poisoning may both be attended by optic neuritis, vomiting, headache and convulsions. Anæmia and hypermetropia occurring together may occasion a momentary difficulty, a slight degree of optic neuritis and sometimes other symptoms being met with under these conditions; but the presence of a disorder connected with vision and the absence of localising symptoms are usually sufficient. It is not so easy with paroxysmal hemicrania, especially when it is associated with hysteria, for the presence of one disease is not absolute proof that there is no other. Cerebral or cerebellar abscess very rarely occurs without a history of injury or evidence of diseased bone. Localised meningitis cannot always be distinguished, as it is present in many forms of tumour, especially syphilitic and tubercular ones, and furnishes some of the symptoms upon which the diagnosis rests.

The diagnosis of the kind of tumour is much more difficult. Age, as already mentioned, is of importance, but at the best it only indicates a slight degree of probability. Definite evidence, either from the history or from lesions in other parts of the body, of a syphilitic or tubercular diathesis is very significant, and should influence the line of treatment very materially, but it cannot be regarded as conclusive. Pseudo-apoplectic attacks are more common in connection with gliomata and gummata than with other forms. A positive diagnosis, however, especially in the early stages, is very often out of the question.

Prognosis.—Syphilitic gummata may be absorbed, and all the symptoms disappear, if only the treatment is commenced sufficiently soon and carried out consistently. If they have already caused extensive destruction of the nerve-tissue around, that of course cannot be replaced; and it is possible that the cicatrix left, dragging upon the brain and anchoring it to the membranes, may sometimes of itself lead to serious after-trouble. It is probable too that tubercular masses are sometimes absorbed or dried up; certainly they not unfrequently remain latent for long periods, but there is not nearly the same degree of control over them. Other tumours pursue their course relentlessly, sometimes leading to coma and compression, or destroying life by the intensity of the pain that accompanies them, sometimes leading to a condition of marasmus, or suddenly causing death by interfering with the respiratory centre in the medulla.

Treatment.—From what has been already said it is clear that, except in the case of gummata and some tuberculous masses, there is little or no hope for diseases of this class except in operation; and that even then the proportion in which this is practicable is a very small one. Nor is there much prospect that, with only our present methods of investigation, it will be materially increased; for the difficulty does not arise so much from the size of the tumour (although this has occurred) as from the impossibility either of localising it or of gaining access to it. If the conditions are favourable, and it is decided to make the attempt, the directions given by Horsley should be followed.

The head should be shaved, washed with soft soap and ether, and thoroughly purified with an antiseptic, the site of the lesion having first been ascertained by measurement and definitely marked. A quarter of a grain of morphia is given before the operation, and the anæsthetic used is chloroform. This has the great advantage of causing contraction of the cerebral arterioles and so diminishing the amount of bleeding; but very great care is required in the management of the anæsthetic, and a very small quantity should be given.

The flap reflected must be of sufficient size, carried right down to the bone at once, so as to bring the periosteum with it, and so arranged that while its main blood-vessels are kept intact, dependent openings are left for drainage. The bone is most easily removed by taking out an inch disc with a trephine to learn the thickness, and then cutting out the piece required with a circular saw mounted on a surgical engine, the separation being completed with bone-forceps; or two trephine openings may be made, one at each end of the exposed area, and the intervening tissue divided with Hey's saw. All the fragments should be carefully preserved between warm carbolic sponges or in a warm dilute carbolic solution, for reimplantation.

The natural colour of the healthy dura mater is difficult to describe. The fibres of which it is composed run in coarse interlacing bundles, so that its surface is irregularly fasciculated; and showing up through them more or less distinctly is the purplish tint of the vascular brain. In cases of tumour it is sometimes reddened and vascular itself, at others adherent to the growth beneath and more yellow. The line of incision should run round four-fifths of the circumference of the area exposed, at one-eighth inch distance from the margin of the bone, so that the edges can be stitched together afterwards. The main branches of the meningeal artery, if they lie in the line of the incision, should be secured by ligature before division. Adherent portions of the dura mater must be removed.

In cases of cerebral tumour, in which there is increased intracranial tension, the brain protrudes into the wound as soon as the dura is divided. If the growth does not occupy the surface, an attempt must be made to ascertain its position by the difference in colour or consistence of the parts of the cortex exposed. Horsley suggests that particular attention should be paid to the presence of any white patches along the course of the cerebral vessels, as indicating old mischief. In several cases an exploratory incision into the substance of the cortex has been necessary.

The arteries that supply the brain are terminal, so that, where it is possible, every main vessel should be left intact; but, as Horsley points out, they can sometimes be raised from the surface of the brain and even drawn out of the sulci without inflicting irreparable damage upon them.

The incisions through the cortex must be exactly vertical, directed into the corona radiata, avoiding, as far as possible, any injury to other fibres, those, for example, running towards the internal capsule. The gap left by removal of a portion of brain fills up at once, the corona radiata bulging upwards and the cut edges becoming slightly everted; so that, owing to the mechanical relations between the brain and the skull, there is normally a tendency to hernia cerebri.

The edges of the dura mater are accurately secured by silk and horsehair sutures. In his earlier operations, Horsley used a drainage-tube for twenty-four hours: later, he discarded this, and merely leaves one inch, unsecured, at the most dependent part.

The fragments of bone should be replaced *in situ* in a kind of mosaic; there is no question as to their vitality being retained or their power of contracting adhesions to the pericranium above and the dura mater below; and so far there is no doubt they add greatly to the security of the flap; but it is not certain how far there is any production of new bone.

Horsley follows Lister's principles strictly, making use of the carbolic spray and carbolic gauze. At the end of five or six days the wound is covered with powdered boracic acid, cotton-wool and collodion. The scalp usually tends to fall in a little at the seat of the operation, but the cicatrix becomes exceedingly strong.

TREPHINING

Trephining is performed either as a precaution to prevent irritation and inflammation of the dura mater by fragments of bone and to secure thorough cleansing, or to procure relief from symptoms that are already present. In the former case, the prognosis, so far as the operation is concerned, is exceedingly good; in the latter, it can scarcely be said to add very much to the risk. If, for example, there is compression of the brain, whether it arises from extravasation of blood, from pus, or from the presence of a new growth, or if a bullet has traversed the brain and fissured the opposite side of the skull, or if insanity or epilepsy follows an injury to the head, trephining may be the only chance of affording relief; but when done under such circumstances as these, for the removal of a condition that has almost proved fatal already, it ought not to receive the whole blame of the result.

The bone is exposed either by enlarging the original wound or by reflecting a flap of skin in such a direction as to secure a dependent opening for drainage (when the patient is lying down) without endangering the blood-supply. The pericranium is best preserved by reflecting it in the flap, laying the bone bare at once. In most cases where mere elevation is required, enough may be accomplished by sawing off a projecting angle or cutting a channel with Hoffmann's gouge-forceps without actually using the trephine. If, however, the original opening in the bone is not large enough for this, a portion must be removed to begin with. The centre pin of the instrument is screwed tight so as to project a little below the edge of the crown, and placed upon the centre of the part that is to be cut away. Then it is worked, with alternate pronation and supination, until a groove is cut in the bone sufficiently deep to prevent slipping. As soon as this is done, the pin is withdrawn to avoid injury to the membranes. The external table is exceedingly hard to saw; the diploe, on the other hand, gives way with ease, and as soon as this is reached the groove becomes filled with soft débris mixed with blood. The inner table, again, is harder, but it is generally possible, when this is partially sawn through, to detach the circle by gently rocking the trephine from side to side, or by means of an elevator. It must, of course, be recollected that the skull is not of the same thickness all over; that in some places the diploe is wanting, and also that, owing to the curves of the vault, one part is usually sawn through before another. It is advisable, therefore, to test the depth of the groove from time to time with the flat end of a probe or with a toothpick, so as to be sure of the progress made; and unless it is done intentionally, the region of the sinuses and the course of the middle meningeal artery should be avoided. If larger portions of bone have to be removed, so as to expose a considerable surface of the cortex, a trephine fixed to a carpenter's brace, or to a surgical engine, may be employed. When the first opening has been made, it can be enlarged in any required direction, either by means of Hey's saws or by the gouge-forceps.

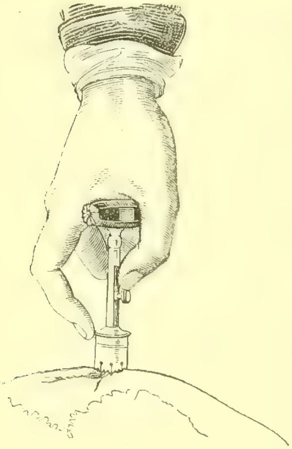


Fig. 278.

The bone removed should be kept warm in a solution of weak carbolic and replaced, either bodily or after being broken up. In many instances, where the periosteum has been laid over it again and the dura mater is not sunken down, the vitality of the bones has been retained, and it has contracted adhesions to the parts near.

When it is a mere question of removing splinters, and the dura mater has not been cut, the flaps are replaced and the wound sewn up (after being thoroughly washed out with corrosive sublimate solution) except at its most dependent part. Generally a drainage-tube is unnecessary, unless there has been a great deal of bruising, or the cavity of an abscess has been laid open, so that union by the first intention is improbable. If the dura mater is incised to any extent, it should be thrown downwards in a flap, as recommended by Horsley, rather smaller than the opening in the bone, in order that, when replaced, it may be readily fixed by sutures, and thus help to maintain the cerebral pressure until union is complete, and avoid the risk of hernia cerebri.

Cerebral Localisation

An elaborate description of the relation between the surface of the scalp and the cerebral convolutions would be out of place in a work of this kind;

a full account may be found in the papers by Reid, Hare, Anderson, Makins and others ; still a few general statements are almost necessary. It must be premised that anything like mathematical accuracy is utterly out of the question ; to say nothing of the differences at different ages and in different types, the same rules often will not hold good in more than a general way for the two sides of the same head.

The fixed points of chief value are the glabella, the inion, the external angle of the orbit, the external auditory meatus and the parietal eminence. The last mentioned, which at first sight appears to be particularly vague, is really of very great value, as it bears a certain relation to the general development of the skull and is nearly always in close correspondence with the supramarginal gyrus.

The most important boundary lines for the brain are the fissures of Sylvius and Rolando and the tentorium. Of these the last is easily marked by the superior curved line ; the two former are more difficult.

The upper end of the fissure of Rolando is most easily defined by the measurement originally given by Thane, half an inch behind the mid-point between the glabella and the inion, supposing of course the fissure were continued quite into the great longitudinal division.

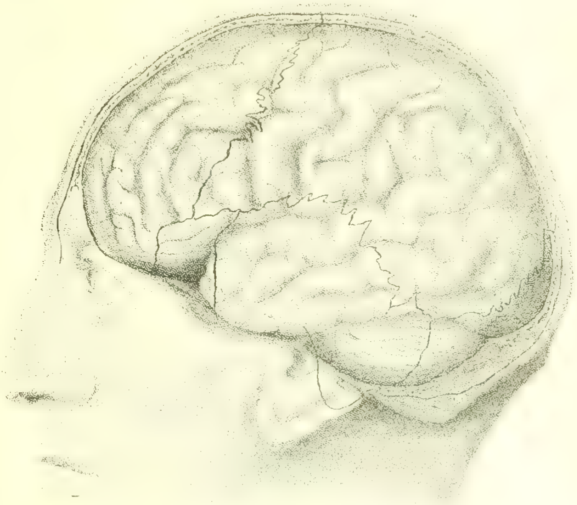


FIG. 279.—The relation of the sutures and the chief points on the skull to the cerebral convolutions. The vertical depth of the temporo-sphenoidal lobe is unusually great for an adult.

The lower does not really admit of definition. The easiest way to arrive at it is by means of Wilson's cyrtometer. A strip of metal (graduated according to Hare's measurements to suit skulls of different shapes) is carried along the sagittal suture from the glabella to the inion ; on this glides a metal rod, about three and a half inches long, forming with the sagittal band a fixed angle of 67°. This when placed in position corresponds approximately in length and direction to the fissure of Rolando as measured upon the scalp. The angle is more open in some brains than in others ; possibly 67° is slightly more than the average, which other measurements place at 65°, but it is sufficiently near for practical purposes: nine times out of ten, that is to say, it will allow a required point to be exposed with a trephine an inch and a quarter in diameter.

The direction of the fissure of Sylvius is equally difficult. Hare takes a base line from the external angle of the orbit to the inion: this passes rather above the external auditory meatus. The beginning of the fissure of Sylvius lies on this rather more than an inch from its commencement, and runs directly upwards and backwards from it to the parietal eminence. Practically the same line may be obtained by starting from the middle of the outer border of the orbit (the external canthus or the sharp margin of bone that lies beneath it) and ending at the same point. The point of bifurcation is approximately three-eighths of the distance from the edge of the orbit.

CHAPTER VIII

INJURIES AND DISEASES OF THE BACK

Section I.—Malformations

Spina Bifida

In the strict sense of the term spina bifida refers to the condition of the spinal column; but it is usually understood to mean a congenital tumour projecting through the ununited laminæ of the vertebræ, and formed of the cord or its membranes, or of both together.

It is nearly always on the back: cases are recorded in which the protrusion has taken place on the anterior aspect of the vertebræ through the bodies; but they are very rare and generally associated with other deformities. Three-fourths of the whole number are found in the lumbo-sacral region, where the medullary groove is open latest; of the rest the majority occur in the neck, but they may protrude through any part, from the occiput downwards, or may even involve the whole length of the column.

Symptoms and diagnosis.—Spina bifida usually occurs in the form of a rounded sessile (sometimes pedunculated) tumour, projecting in the middle line of the body, over the spine, with which it is closely connected. It may be of any size, larger even than the child's head. In some instances the skin over it is natural; in most it is reddened, devoid of hair, and exceedingly thin; in a few it is vascular, like a nævus, and velvety so far at least as the most prominent part is concerned; and occasionally there is a great growth of hair all round it, converging in a spiral fashion towards the central point. The swelling may be perfectly uniform in shape, or there may be a longitudinal groove running vertically downwards over it in the middle line, beginning and ending with a little pit-like depression; and sometimes in addition two lateral grooves can be made out, wide apart at the centre, but converging at their extremities towards the same small pits.

The sac is very often translucent, and the nerve cords can be traced by transmitted light running obliquely across it. Fluctuation is distinct, and when the neck is wide the wave can be felt even at the anterior fontanelle. The tension varies according to the quantity of fluid present, increasing if the child cries or if the pelvis is allowed to hang down. Some of the contents can often be reduced by steadily compressing the sac, so that the edges of the cleft can be felt; but the proceeding is a dangerous one, likely to cause convulsions.

Complications are often present. Talipes, paraplegia, and atony of the external sphincter are due in all probability to the condition of the sacral plexus, and point to the fact that the spinal cord, or the nerves coming from it, are involved in the sac; meningocele, ectopia of the viscera, and other malformations result from a similar arrest of development in other parts of the body.

The diagnosis rarely presents any difficulty. The position of the tumour, its congenital origin, and its varying tension are sufficient to distinguish it from everything but nævus. Every now and then, however, other forms of congenital tumour closely resembling it are met with in this region. False spina bifida is the most deceptive. Strictly speaking it is a single cyst, in communication with the spinal canal, but not with the membranes or the cord; and probably it originates from the sac of a true spina bifida, the neck of which has become occluded. But congenital lipomata and even myolipomata are known to occur, springing from the interior of the spinal canal and spreading out, either between the arches, or through an opening left by their imperfect growth until they form large masses sessile upon the backbone. The true multilocular sacro-coccygeal tumours are, as a rule, in connection with a part of the spinal column which is not the seat of spina bifida.

Pathology.—There are three chief varieties of spina bifida, of which the second is by far the most common.

(*a*) *Meningocele.*—Protrusion of the membranes only: the skin covering it may be thinned and reddened, but in other respects it is perfectly natural. The cord lies in its proper situation and there are no nerves in the sac.

(*b*) *Meningomyelocele.*—Protrusion of the cord with its nerves and membranes. The skin around the neck of the tumour is natural; over the most prominent part it is replaced by a thin vascular layer which shows no trace of corium, hairs or sweat glands; and the line of transition in sharply marked. This layer is the flattened out spinal cord itself, which in the most typical examples leaves the spinal canal at the upper angle of the cleft, passes backwards across the sac until it meets and fuses with its posterior wall, and then leaving it after a variable distance, regains the canal below. In some instances the cord is structurally complete; and although the normal arrangement of white and grey substance is somewhat interfered with, the central canal can still be recognised in transverse microscopic sections. In others the cord itself is flattened out from in front; the posterior fissure has never been closed; and the central canal forms the median groove already mentioned, ending in a pit above and below where it resumes its normal situation. Finally, in a few the pressure of the fluid in front of the cord has been so great that the anterior columns are separated, and between them there is a vascular velvety protrusion of pia mater. The position of the nerves is of course considerably modified: the anterior roots spring from the concavity of the roof of the sac near the middle line; the posterior ones arise from it farther down the sides, with between them an enormously elongated ligamentum denticulatum. Sooner or later the roots fuse together to form a trunk, which, running partly in the wall of the sac, partly across its interior, passes between the margins of the cleft into the spinal canal, in order to gain its proper intervertebral foramen. The dura mater lies on the posterior surface of the bodies of the vertebræ, and can be traced into the wall of the sac as far as the covering of true skin, never farther. The sac, in other words, is an immensely distended subarachnoid space.

(*c*) *Syringocele.*—The central canal of the spinal cord is dilated, forming the cavity of the sac; the posterior wall is formed of skin as a rule, with the expanded posterior columns of the cord, and perhaps the dura mater.

In all of these there is a defect in the arches and laminæ of the vertebræ (spina bifida); much rarer deformities are sometimes met with, chiefly in association with syringocele, itself very rare; defective development of the bodies of the vertebræ, for example, so that they are either cleft vertically, or that one half is wanting; growth of a bony process backward through the substance of the spinal cord and even complete division of the spinal cord into two for more or less of its length.

From the fact that in sacral spina bifida the cord is found still occupying the sacral region (the nerves coming off horizontally without forming a cauda equina), while at birth it has normally receded far up the lumbar part, it is clear this deformity originates at the very earliest period, when the spinal cord and the vertebral column are practically of the same length. The defect is in the formation of the medullary canal.

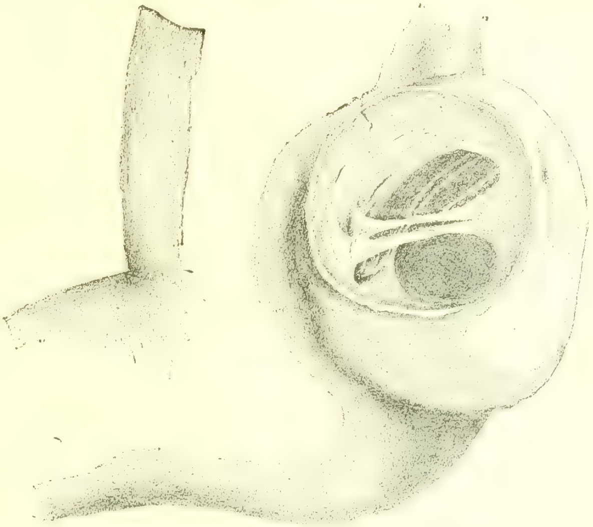


FIG. 280.—Meningomyelocele laid open. The centre is marked by a pit leading down to the spinal canal. Below this is a trifid groove. The whole of the posterior surface is composed of flattened-out spinal cord, the line at which the true skin stops being clearly marked off. In the interior the ligamentum denticulatum and some of the roots are stretched across from back to front.

Spinal meningocele is the most simple. In this the neural canal has closed so that the cord itself is well formed; but the mesoblastic elements which should grow around it and enclose it on the dorsal surface are imperfectly developed; the bony laminæ, the muscles and the substance of the true skin are deficient in various degrees (according to Recklinghausen, the dura mater is wanting in this as well as in the other forms); and the protrusion is due to passive distension; fluid is secreted in the sac under the pressure of the blood, and the wall is too thin and weak to resist.

In meningomyelocele the fluid collects in the subarachnoid space in front of the cord; if the neural canal is closed already, the cord itself is gradually flattened from before backwards and pushed out from the cleft, until it joins and fuses with the epidermic covering developed from the epiblast, the sole trace of all the structures that should protect the spinal cord behind. In this case a transverse section through the posterior wall of the sac reveals, on microscopic examination, the flattened out central canal, and there is no median groove or pit. In the other form the defect occurs at an earlier period still, before the medullary groove is closed to form the cord and the layer of elementary nerve-tissue is first flattened out, and then becomes convex backwards, until at length it projects as the covering of a thin-walled cyst. In the most extreme cases the anterior columns are so far separated from each other by the pressure that a strip of pia mater, that which should line the bottom of the anterior fissure, forms a longitudinal velvety band on the most convex portion of the sac.

The other malformations are due to the fluid collecting in the central canal, and to inequality of growth of various parts of the vertebral column. The bifurcation of the spinal cord is probably an indication of the enormous power of reproduction and repair possessed by the embryo at the earliest period. If the neural canal is prevented from closing into a tube, each half may in some instances be capable at that time of life of forming one for itself.

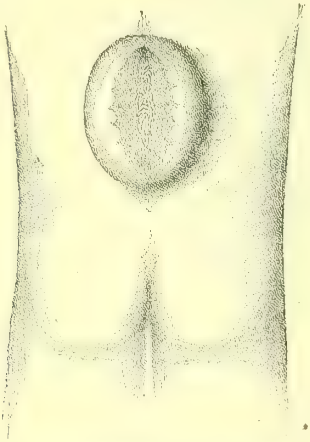


Fig. 281.—Meningomyelocele, showing the vascular pia mater in the centre, the flattened cord on either side, and, above, the pit leading to the central canal (diagrammatic).

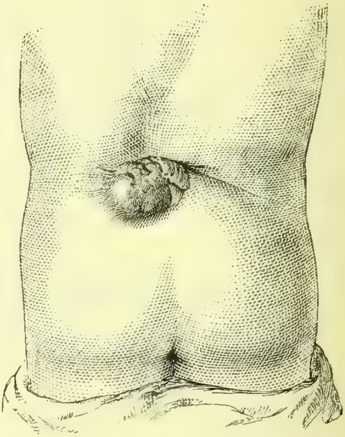


Fig. 282.—Cured spina bifida, taken from a man æt. 26.

Treatment.—If the protrusion is small, covered over with healthy skin, and not inclined to enlarge, it should be carefully protected with cotton-wool and collodion in sufficient thickness to form a fairly rigid covering, or with a gutta-percha cap. There is a possibility of its gradually shrinking up. In most cases, however, the sac is increasing rapidly and threatens to give way sooner or later if left to itself. If the skin is already ulcerated or the wall is actually broken, it should be dusted over with iodoform and carefully packed with iodoform gauze or salicylic wool, in the hope that meningitis will not follow, and that the wound will cicatrise under the protection.

The only treatment that has met with any success is the injection of Morton's fluid: this consists of iodine gr. x., pot. iod. gr. xxx. and glycerine ℥j. A puncture is made with a fine trocar and cannula through the healthy skin near the bottom of the sac, and a certain quantity of the fluid, not more than half, allowed to escape. Then half a drachm to two drachms of the solution is injected, taking care that none escapes by the side in the cellular tissue, and the puncture sealed with collodion. The opening may be made valvular to prevent the contents draining away. Afterwards the sac must be carefully packed in cotton-wool with a slight amount of pressure, and the child kept as quiet as possible, so that the injection may not diffuse itself too rapidly. In successful cases the sac soon begins to diminish in size, and at length shrivels up into a rounded solid excrescence; but very often several injections are required, and it not unfrequently happens that after a little while the skin becomes red and the opening begins to leak, or the child is attacked by convulsions and meningitis sets in.

Excision of the sac has been practised successfully in cases of simple meningocele, but as it is impossible to prove that the spinal cord is not involved in the sac, this operation should very rarely be undertaken.

The prognosis is rarely favourable. Even in simple cases the child is seldom well nourished; in the more severe ones—when, for example, there is a large thin-walled sac—it is nearly always small and puny; and in many there is clear evidence from the first of paralysis or other nerve-lesions. Growth, especially of the lower limbs, is usually stunted; areas of anæsthesia persist; some of the muscles of the lower extremity continue in a state of spastic rigidity so as to limit the action of the joints; and handling the cicatrix left may in some instances give rise to evidence of nerve-irritation, passage of urine, defæcation, and sexual emissions.

Congenital Sacral Tumours

A great variety of congenital tumours is met with in connection with the sacro-coccygeal region, and the origin of many is still involved in doubt.

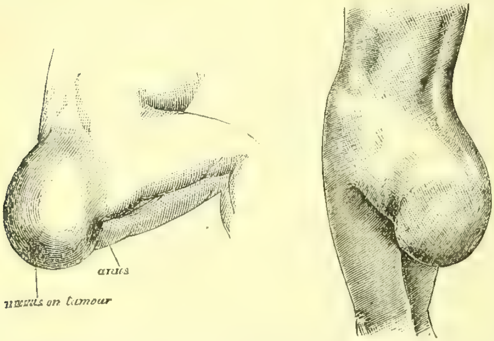
(*a*) *Spina bifida* (true and false) may occur on the back of the sacrum. Its diagnosis and treatment have already been discussed.

(*b*) *Congenital lipomata and myolipomata* are also met with, springing from the interior of the spinal canal and protruding through an opening in its wall. Similar growths, due in all probability to the accidental transference of tissue-germs at a very early period of embryonic life, are also met with higher up in the column. When small their diagnosis from spina bifida is almost impossible without a puncture. They have been excised with success.

(*c*) *Congenital sacral tumour*, in the limited sense of the term, is applied to a mass, often of enormous size, developed in the region of the coccyx, in front, displacing it; or behind; or hanging from it by a neck. It is made up of cysts of all sizes, from that of a pea to a horse-chestnut, communicating more or less freely with each other, and filled with a thick gelatinous material. When small the epithelium lining them is columnar, resting upon flatter cubical cells. In between is a variable amount of fibrous tissue with fat, hyaline cartilage, and sometimes even bone. It seems probable that this growth originates from Luschka's gland, which in its turn (according to Bland Sutton) is the rudiment of the post-anal gut of the embyro. Excision is the only line of treatment possible, but very careful examination is necessary, as not unfrequently the growth extends much farther up the pelvis or the spinal canal than would be imagined from external appearances.

(*d*) *Dermoid cysts*, containing the ordinary mixture of sebaceous material, hair, &c., are not uncommon. Sometimes they communicate with the rectum or bladder, and occasionally they are of very large size, extending long distances up the pelvis. As Bland Sutton has pointed out, there is an especial tendency to the production of these growths in those localities in which fusion of the germinal layers takes place in the embyro.

(*e*) Finally, *attached fœtuses* of all grades of development may be met with. There may be merely a shapeless, formless mass of skin, containing fibrous tissue, bone, and fat, all mixed up together; or a well-formed limb; or even larger portions still. Excision is the only treatment practicable, flaps being formed from the part removed for the purpose of covering in the stump; but full examination of the connections should be made in every case, as it is impossible to say how far growths of this kind may be incorporated with the bearer of them.



Figs. 283 and 284.—Congenital coccygeal tumours.

Section II.—Injuries

INJURIES OF THE BACK

Injuries of the back, like those of the head, derive much of their importance from the danger to which the great nerve-centres are exposed. Independently of this, the structure of the spinal column is so complex, its position as the axis of support for the trunk and the chief base for the movements of the body so important, that no injury, however slight, can be inflicted upon it without producing a serious, and often a widely felt, effect.

Sprains and Wrenches

These are very common, especially in the flexible parts, the cervical an lumbar regions; sometimes they are chiefly muscular, as in cases of over work—lifting heavy weights, for example—or in sudden awkward twists sometimes, when due to external violence, they involve the fibrous texture the ligaments, fasciæ, and synovial membranes as well, the muscles eithe being caught unawares by the unexpected jerk, or being overpowered. Th worst of all occur in railway collisions, when, suddenly and without an warning, before a single muscle can contract, the body is wrenched an twisted, or thrown with overpowering force from one side of the carriage the other, until every muscle or ligament that has an attachment to the spine is strained or hurt.

For various reasons, the spinal cord itself escapes more frequently than might be expected; it lies in the central axis, so that in all movements it occupies neutral ground; it is separated by some distance from the walls; around it there is a water-bed, probably always filled with fluid; and in the lumbar region, where the range of movement is as great, perhaps greater than anywhere else, its place is taken by the cauda equina.

The extent of injury in these cases is very variable. No structure is always exempt, but probably the muscles and fibrous tissue are the greatest sufferers. The former may be thrown into a state of cramp; they may be torn or wrenched away from the bone; there may be hæmorrhage into the sheath that invests them; this may be torn and the muscular substance forced through the rent like a hernia; or, especially in the neck where the long slender slips lie closely packed together side by side, there may be a real dislocation. The latter may be still more damaged; the broad sheets that extend on either side of the spine may be overstretched, or the loose cellular tissue that fills up the irregular spaces around and between the bones crushed and bruised; or, what is much more serious, some of the ligaments that connect the vertebræ may be strained until they yield. This is especially dangerous, not only from the proximity of the membranes and the cord and the risk of their being injured at the same time, but from the danger of hæmorrhage and inflammation. A certain amount of extravasation must always occur, causing an ill-defined swelling and tenderness, and giving rise to pain and inconvenience when any attempt at movement is made; but if the posterior ligaments, especially the ligamenta subflava, are torn, the bleeding may be very severe, owing to the size of the veins that surround them, and the blood may pour down the spinal canal.

In other cases, the spinal nerves are hurt, stretched possibly as they pass ut through the foramina, or compressed by extravasation, so that the effects re referred to distant parts of the body. Even the bones and joints do not scape, for, though it is rarely possible to prove the existence of definite injury t the time, it is certain that inflammation may break out in them afterwards.

The complications that follow these injuries depend largely upon the tate of the patient's health. Stiff neck, lumbago, and chronic rheumatism ccur in some, particularly after middle life; synovitis and osteoarthritis, aving the spine rigid, anchylosed, and perhaps distorted, occur in others; aries is exceedingly common, especially in children and young adults; and, hat is still more serious, if the ligaments have been torn and hæmorrhage as taken place in the vertebral canal, inflammation of the membranes or the cord itself may follow. In most cases this is very insidious; softeng sets in slowly, and steadily grows worse and worse; in a few rare stances it is acute, suppuration commencing externally in the broken-down ood-clot or in the joints, and spreading through a rent in the membranes along the lymphatics, until the dura matral sheath is involved. This is t so frequent as in the skull, owing to the wide separation between the ra mater and periosteum, and the lower vascularity of the former in the inal canal; but it has proved fatal in many cases of latent fracture.

Sprains of the back have acquired a peculiar significance from their quency in railway collisions, and attempts have been made to distinguish em, when they occur under these conditions, from others. Except, however, for their severity and for the fact that they are always associated with a very grave degree of shock, which is certainly not without influence upon the subsequent progress of the case, there is no reason for such a step.

Symptoms.—The chief ones are pain and stiffness: these are never absent. The former may be immediate and severe, as when the head is twisted round to look in some awkward direction, and a muscle or tendon is caught or displaced; or it may be dull and aching, not coming on for hours. The least attempt at movement makes it tenfold worse. Very often it is especially severe at night, when the patient is getting warm in bed; and usually the skin over the painful part is exceedingly tender, as it always is over muscles that have been overstrained or overworked. If the nerves are injured in the foramina the pain runs round the trunk like a girdle, or extends into the limbs; sometimes it is attended by formication. In one case, in which the lumbar region was severely wrenched, a patient described it as shooting like lightning down the legs, and very often it is referred to the distribution of the nerves—to the pubic region, for instance, when the injury is at the junction of the dorsal and lumbar vertebræ. The stiffness is to a great extent the result of this; the neck and back are held perfectly rigid, and if the patient is asked to pick up anything from the floor, the knees and hips are flexed, and he lowers himself carefully down. Very often patients imagine they are paralysed, mistaking the difficulty of movement arising from the pain for actual loss of power; and this may be very misleading. I have recorded elsewhere a case in which, after a muscular strain of the neck, the patient believed that he could neither hold his head upright, without supporting it with his hands, nor open his mouth; and it is not uncommon to find after a strain of the loins, that defæcation and micturition are attended with difficulty, not because the spinal cord has been injured (though it must never be forgotten that this may be the case), but because these actions depend so largely upon the integrity of the muscles that support the back. The same thing occurs in lumbago, when it is due to cold, without there being any suspicion of injury; but it cannot be denied that, especially after railway accidents, it is a very disquieting symptom.

Swelling is not common in accidents of this kind, unless there is a considerable extravasation; it may follow the outline of the muscles, as in the neck, or simply form a smooth, rounded elevation. The skin, as already mentioned, is often very tender, but, as a rule, firm pressure gives relief. Redness is hardly ever seen, and it rarely happens that the temperature is raised.

Hæmaturia is not an uncommon occurrence after sprains of the lumbar region; the urine is bright red for a day or two, and sometimes there is sufficient blood to form a clot in the ureter; then it gradually becomes smoky, until, as a rule, the whole has disappeared in about a week. It is seldom serious, but I have known it fatal, probably from one of the larger arteries having given way.

Treatment.—As in the case of sprains elsewhere, rest is the first consideration, to limit the amount of extravasation and hyperæmia that follows, and then gentle passive movement to assist in absorption and to restore the function and nutrition of the part. If there is one spot especially tender, or one particular movement that causes pain, immediate relief may sometimes be obtained by suddenly throwing the muscle concerned into vigorous action. Subcutaneous injections of morphia must generally be used, as the pain is often so severe that the patient has not the power to make the effort. In twists and ricks of the neck and loins this plan may be tried at once. Where the aching, stiffness, and pain on movement are more general, and it is clear that the symptoms are due to chronic changes in the joints and muscles, and that the spinal cord is not involved, counter-irritants may be employed. Hot baths, shampooing, friction with stimulating liniments, ironing, blisters, acupuncture, and galvanism with slow interruptions of the current, are of the greatest value, but constitutional treatment must not be neglected, especially if there is any evidence of gout or rheumatism. Muscles and joints are intended for work; if they are injured they require rest it is true; but as soon as the damage is repaired they become stiff and waste unless they are used; and the longer they remain at rest the worse they become.

In cases of more severe injury, when there is either shock or excitement, the patient should be placed in bed, and kept warm and as quiet as possible until it has entirely passed away. The urine may have to be drawn off, especially after railway accidents or other severe injuries; the bowels are almost sure to be constipated and should be opened by a calomel purge; stimulants, unless the pulse is very feeble or actually failing, do more harm than good. Then, as soon as the acute symptoms have subsided, when the patient begins voluntarily to change his position in bed, gentle passive motion, bending the spine backwards and forwards, and massage may be commenced, to prevent the muscles becoming rigid. If the depression continues, or if some weeks after the accident the patient does not begin to rally, the prognosis becomes very grave. There is evidence then that the nervous system has been seriously affected; and in patients of a neurotic temperament, or where there is any hereditary taint, it is impossible to predict what may happen. Perfect rest for mind as well as body is essential; everything that can worry or annoy must be carefully kept away, and the attention must be diverted as much as possible by change of scene or occupation. Good food, fresh air, and a moderate amount of such exercise as the patient can be induced to take are the best remedies; stimulants should be avoided. The only drugs of any service are those that improve the appetite and help to keep up nutrition; bromide of potassium and sedatives or narcotics usually do harm.

Fractures and Dislocations of the Spine

Fracture

The vertebral column may be broken either by direct or indirect violence. The former, is the most rare, at least in civil practice; but a violent blow, or a fall, striking the back against a projection, may crush it in at any point. The extent of the injury is very variable; if the force is slight, one of the processes only is broken off; more frequently the laminæ are driven in; sometimes the bone is completely broken up. Fracture by indirect violence is generally the result of extreme flexion; the head, for example, is caught in driving under an arch and forced down upon the sternum (sometimes breaking this too); or the neck is fractured by diving head foremost into too shallow water; more rarely it is caused by over-extension. When the fracture is the result of flexion the spine usually gives way either just above or just below the dorsal region, the seat of junction of the more movable parts with the more rigid; and the injury is always very extensive. The muscles are torn; the spinous processes are dragged asunder; the ligamenta subflava are pulled away from their attachments; the body is wrenched off the adjacent disc and crushed in; blood pours down the spinal canal, or is extravasated into the sheath; and the upper part of the spine carrying the head is displaced forwards, so that the edge of the vertebra below pins the spinal cord against the arches; or, what is worse still, a triangular piece of bone is broken out of one of the bodies and driven backwards like a wedge across the spinal canal (fig. 285).

Dislocation

True dislocation, without fracture, is met with in several parts of the vertebral column. In children it may occur between the atlas and axis from lifting them up by the head; in hanging there is usually a fracture running through the base of the odontoid process. It is most frequent in the lower part of the cervical region, especially between the fifth and sixth; here the articular processes look backwards and forwards, and are easily separated from each other by extreme flexion without any fracture taking place. Sometimes, when the force is spent, they fall back into position again, so that, though the spinal cord may have been completely disorganised, there is no permanent deformity; in other cases they are caught and fixed, and then, generally speaking, the body of the vertebra is displaced as well (fig. 286). The same thing has been known to happen between the two last dorsal vertebræ, and also between the twelfth dorsal and the first lumbar; in other parts it is very rare.

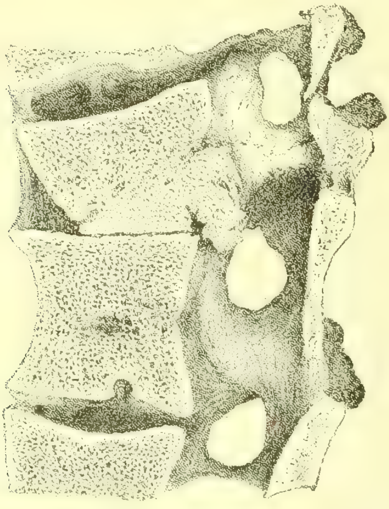


FIG. 285.—Fracture of spine. Part of the body of the upper of the two vertebræ is driven backward into the spinal canal, causing hopeless disorganisation.

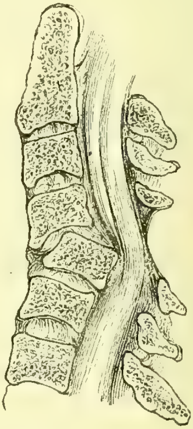


FIG. 286.—Dislocation of the spine.

Unilateral dislocation can be produced in the cervical region by rotation. If the head is suddenly twisted round while the neck is partially flexed, the movement may be carried a little too far and one articular process displaced from another. It may be the result of muscular action only, or of direct violence applied to the side of the head. The symptoms are usually characteristic: the face looks downwards and is inclined to one side; the neck is slightly bent; the muscles on the convexity are in a state of spasmodic contraction, in the concavity they are quite relaxed; the spines are not irregular, but some projection can be felt to one side of the middle line; and the least attempt at movement causes the most intense pain. Sometimes there is difficulty in swallowing, and a projection can be felt in the pharynx with the finger. Nervous symptoms may be altogether wanting; more frequently there is intense pain, formication, or anæsthesia, corresponding to one or more of the roots of the cervical or brachial plexus; in most there is evidence of pressure upon the cord, difficulty of respiration, weakness or paralysis of the extremities; and even when these symptoms are not present at first, they generally make their appearance later on, if the dislocation is not reduced, caused in all probability either by hæmorrhage or by inflammation and softening.

In the majority of cases of fracture, or of complete dislocation of the spine, the injury inflicted upon the cord is beyond repair. The dura mater, when the canal is laid open, may appear to have escaped, but only too frequently everything inside it is reduced to pulp. In exceptional cases the chances are better; if, for instance, a spinous process only is broken off, or an articular one displaced, there may be merely bruising or compression from hæmorrhage into the sheath of the cord or into the spinal canal; but if the fracture involves the laminæ, or if the ligamenta subflava are torn, the effect is rarely limited to this. In the lumbar region there is better hope: the cord occupies a smaller space in the spinal canal; the displacement is less, owing to the greater size of the bodies; and the cauda equina, formed of nerves which are tough and firm, escapes more easily. In pure dislocation the prospect is a little better than it is in fracture, for though the displacement may be no less, the risk of fragments being driven into the substance of the cord is certainly not so great.

If the patient survives the immediate injury there is always the danger of diffuse spinal meningitis and red softening of the cord. The former is more common after gunshot injuries, but even in simple fractures it sometimes begins around the bones and joints; the latter is nearly always present in greater or less degree in cases that prove fatal after a few days or weeks, starting from the seat of injury and extending upwards as well as downwards. It is more likely to happen after severe injuries, but none are exempt.

Symptoms.—(*a*) *Those that depend upon the injury sustained by the bones and ligaments.*—Undue mobility, deformity, and crepitus are present in fractures of the spine as in most others; but, so far at least as the first and last are concerned, no attempt should ever be made to elicit them. They are not required for purposes of diagnosis, and might, probably would in many cases, inflict still further injury upon the cord. With deformity it is different: the hand should in all cases be carried gently down the back, feeling each spinous process in turn without disturbing the patient, so as to ascertain if there is any irregularity. It may be necessary to reduce it at once. In addition, pain is always present, and is made worse by movement or by pressure. Generally it is limited, but sometimes it spreads down an arm or leg or round the trunk, owing to one of the nerves being caught at the seat of fracture.

In a few cases these are the only signs; the fracture may be latent, especially in the lumbar region. One or two vertebræ are exceedingly tender; there is a sense of weakness or want of support when standing up; lying down, the patient can move his limbs with such freedom that I have known it necessary to put a certain amount of restraint upon their action; but there may be no other sign. Sudden displacement, however, may occur at any moment; hæmorrhage may spread into the canal; meningitis or myelitis may set in; even suppuration may follow and extend along the cord or lead to caries or necrosis of the bones. In the neck latent fracture is more rare, but a few instances are recorded in which patients have continued to get about even for days without its being suspected. Weakness of the extremities; a sense of insecurity in the movements of the head, so that it must be supported by the hands; pain along the course of the occipital nerves; even slight deformity may be present; and yet the patient be unaware of the risk that he is running. In a few of these cases the symptoms have gradually subsided, a certain amount of stiffness only has been left, and the patient has recovered; in one a portion of bone, recognised as the odontoid process, was discharged through an abscess; more frequently death occurs either instantaneously from sudden displacement, or gradually from myelitis.

(*b*) *Those due to injury of the spinal cord or nerves.*—In most cases, even when no displacement is apparent, the cord is completely crushed and the power of conduction and reflex action lost. The former never returns: a clean division of the spinal cord might possibly be repaired, even in man; hemisection certainly may; but the injury sustained in accidents of this kind is much too grave. The latter, if the patient survives, returns to some extent as the shock wears off, and may in some cases become exaggerated. Recently Bowlby has pointed out that, so far as men are concerned, there is a material difference in this respect between the behaviour of the superficial and deep reflexes: the former may return, whether the cord is crushed completely or not; the latter never do unless some part still remains unhurt. If this is substantiated it must become a factor of very great importance both as regards prognosis and treatment.

Another sign of great significance has been pointed out by Thorburn; when the violence is extreme, the roots of the spinal nerves are crushed and torn as badly as the cord itself, and the area of anæsthesia corresponds anatomically with the seat of the lesion. If, however, the force is not so great, the nerve-roots lying by the side of the cord may escape, even though the cord itself is crushed, and thus give rise to an apparent discrepancy, especially in the lower dorsal and lumbar regions. The prognosis in the former case is certainly much worse, and if ever surgical interference is justifiable, it can only be in the case of the latter.

If the injury is not so severe, as for instance happens occasionally in the lumbar region, motion is always more affected than sensation; and although perfect recovery is rare, a certain amount of repair may take place, leaving more or less anæsthesia and spastic rigidity. When due to hæmorrhage the symptoms, as a rule, begin gradually; there is an interval of a few minutes, or even of some hours; and, as Horsley has pointed out in the case of tumours pressing upon the spinal cord, the paralysis of motion spreads from above downwards, the anæsthesia in the opposite direction. In the slighter cases, when the blood is absorbed, the symptoms begin to disappear again, following the reverse order; but perfect recovery is uncommon, and not unfrequently after temporary improvement red softening sets in.

Occasionally the symptoms occur in such a peculiar manner that it is difficult to believe they can be due merely to suspension of the activity of the cord. Limited hyperæsthesia, for example, is very common; sometimes it becomes general, and is so intense that the slightest touch causes agony; muscular wasting is the rule; but every now and then cases are met with in which it is so rapid that it is difficult to believe that it is only the result of disuse. The most striking examples, however, are sloughing of the skin, and inflammation of the urinary organs. Both of these are common results of fracture of the spine, and in nearly every case admit of a local explanation; but occasionally they are so intense, so rapid, and attended with such an amount of congestion and extravasation that it has been suggested they must be the result of irritation of the cord. Symmetrical patches of skin on the inner sides of the thighs, for example, where there can be no pressure, have sloughed and become gangrenous in a few days; suppurative nephritis has set in within forty-eight hours; and weeks after the accident the most intense cystitis has suddenly broken out and proved fatal without the slightest evidence of any local cause. Moreover, in one or two cases these lesions have occurred when there has been no fracture at all, but merely hæmorrhage into the grey substance of the cord and red softening.

The nature of the symptoms and the prognosis depend upon the seat of injury: loss of sensation, for example, extending as high as the umbilicus, points to injury of the eleventh dorsal vertebra; if it extends to the ensiform cartilage, above the sixth. The superficial origin of the nerves only corresponds to the point of exit from the canal in a very few instances; and, as Reid has shown, varies immensely with regard to the spinous processes. The first dorsal, for instance, which passes out below the first dorsal vertebra and helps to form the ulnar, is nearly always destroyed in fracture of the seventh cervical; the second, third, and fourth lumbar are at their origin opposite the eleventh dorsal; while the whole of the sacral plexus corresponds roughly to the upper border of the first lumbar. Further, owing to the softening of the cord that follows injuries, it generally happens that a day or two after the accident the paralysis and loss of motion extend upwards towards the head.

Injuries of the Upper Cervical Vertebræ

Dislocation of the head from the atlas is very rare, but can be produced by a violent blow upon the occiput while the patient is stooping forwards. Fracture of the atlas is nearly as rare; dislocation from the axis with fracture of the odontoid process is the common form. The check ligaments are stronger than the bone, so that this gives way either at its base, or more frequently below, through the body of the axis. Dislocation without fracture is seldom met with, but may occur in children, owing to the smaller size of the odontoid process, and, possibly, in adults when the injury is the result of violent rotation, the check ligaments, as it were, being torn across in detail.

Injuries of this character are, of course, usually fatal at once; the lower end of the medulla and the upper part of the cord are destroyed by the odontoid process being driven in. In a very few instances, however, life has been prolonged, owing to the large size of the ring of the atlas and the thickness and toughness of the attachment of the dura mater to the margin of the foramen magnum. Sometimes, in these cases, sudden displacement has taken place after hours, and even after days.

Fracture immediately below this is equally fatal owing to the phrenic nerve. The main root comes out with the fourth cervical. If the centre is destroyed death is practically instantaneous, as diaphragmatic and intercostal respiration are both interrupted.

Injuries of the Lower Cervical Vertebræ

The most common seat of fracture as well as dislocation lies between the fifth cervical and the first dorsal; and, as a rule, the cord is completely crushed. Motion and sensation are entirely lost in the trunk and lower part of the body. In a few cases there is a want of symmetry at first; the paralysis may extend one or even two nerves higher on one side than on the other; but as softening sets in this soon disappears. Immediately above the paralysed region there is a zone of hyperæsthesia; when this is immediate, it can only be explained by the mechanical irritation of the nerves above the seat of injury; more frequently it does not make its appearance for some hours, not until the circulation in the parts round the injured area has become more active. Owing to the shock, reflex action is at first entirely suspended; the cutaneous reflexes give no response; irritation at the neck of the bladder or at the anus has no effect; the function of the part of the cord below is, for the time being, practically abolished; the vaso-motor nerves are paralysed, the blood-pressure falls, the secretion of urine is diminished, the heart beats very feebly, and the pulse is rapid, small, and soft.

In injuries through this region the fibres of the sympathetic that supply the dilator pupillæ must be paralysed, so that dilatation of the pupil cannot take place. It is, however, difficult to estimate, as it occurs on both sides, not on one only, as when the brachial plexus is torn away from the cord, and the degree of contraction is not very marked.

The actual distribution of paralysis and anæsthesia depends naturally upon the seat of the lesion, but there is considerable difficulty in ascertaining the exact centre and nerve-root for individual muscles, and without this, of course, perfect localisation is impossible. The following table, founded almost entirely upon clinical data, is taken from Thorburn, doubtful muscles being excluded:—

4th	cervical nerve	supplies the	supra and infra-spinatus.
5th	,,	,,	abductors of the arm, supinators and flexors of the elbow (biceps, brachialis anticus, deltoid and supinators).
6th	,,	,,	adductors of arm, pronators and extensors of elbow (subscapularis, this appears to be the highest; pronators, teres major, latissimus dorsi, triceps, pectoralis major).
7th	,,	,,	extensors of the wrist.
8th	,,	,,	flexors of the wrist.
1st dorsal	,,	,,	interossei and intrinsic muscles of the hand.

These, of course, as Thorburn points out, are only the chief points of origin, minor connections not being regarded. Thus, if the injury is above the sixth cervical, the elbow is flexed and supinated, the arm abducted, and the wrist and fingers motionless—a most characteristic attitude; if below this, abduction and supination are better performed, and a certain degree of extension and adduction is possible, but there is still no power over the lower joints.

The level of the anæsthesia is not so difficult; the fifth root, the first of the series supplying the fore-limb, is distributed to the region of the deltoid and the outer aspect of the arm and forearm as far as the base of the thumb; the eighth and first dorsal supply the inner side of the arm, forearm, hand, and little finger; the sixth and seventh are distributed to the intervening spaces on the anterior and posterior surfaces.

Respiration is embarrassed from the first. All the muscles that raise the ribs and help to enlarge the thorax are paralysed; only the diaphragm is left. Inspiration is carried on with difficulty; instead of the chest expanding when the diaphragm contracts, so that at the end of the act it is distended in all directions, it collapses and sinks in, and the work of the diaphragm is in great measure lost. Expiration is worse still; at the commencement, when the chest ought to be dilated to its utmost, ready to recoil from the elasticity of its walls as soon as the muscles relax, it is already contracted, and every expiratory muscle is paralysed. The only forces left are the elasticity of the partially-distended lungs and the weight of the abdominal viscera which have been pushed downwards and forwards Coughing is impossible; full expansion of the lungs cannot take place; the bronchi become plugged with mucus, and the blood gradually stagnates at the lower and back part of the lobes, until the respiration, growing worse and worse each moment, and the action of the heart becoming feebler, hypostatic congestion or pneumonia sets in. Generally this proves fatal in the course of a few days.

As the shock passes off, the character of the symptoms begins to change. The loss of motion and sensation remains unaltered, or possibly extends a short distance higher up, but the superficial reflexes gradually return. If their recovery is long delayed, or if, having once returned, they begin to fail again, the prognosis is very grave; in one case it points to injury so serious that it may prove fatal before reaction can set in; in the other to progressive softening of the cord.

The first sign is the recovery of the circulation: the heart begins to beat more firmly, the skin becomes warm, and the state of extreme prostration passes off. In fracture through this region, however, strange variations are not uncommon. In some cases, the pulse becomes abnormally full, slow and deliberate; in others the temperature falls immediately after the accident, and, in spite of the shock passing off, continues to drop until in one instance it is said to have reached 80° 6′ F. More frequently it rises rapidly; I have known it ascend from 93° F. to 109° F. within thirty-six hours; and higher temperatures than this, persisting and sometimes even rising after death, have been recorded on many occasions. It is impossible to avoid comparing this with the results of curare-poisoning, but it cannot be said to explain it in any way. As has been shown by Hutchinson, high temperatures are always associated with vigorous action of the heart and full throbbing pulse.

The secretion of urine is but little altered; the quantity is scanty at first, owing to the general fall in the blood-pressure; but as the shock passes off it increases again. Sometimes there is hæmaturia without any direct injury to the lumbar region, possibly from extreme distension of the capillaries; and it is said that the urine, as secreted by the kidney, is not unfrequently alkaline in reaction.

Micturition is always affected. At first there is complete retention; the lumbar portion of the spinal cord has, for the time being, completely lost its power, and the urine simply accumulates in the bladder. If this is not relieved, the result is merely a question of relative pressure; the bladder becomes more and more distended, until, if left sufficiently long, its muscle passes into a state of atony, the elastic resistance of the sphincter gives way, and the urine flows out drop by drop, leaving the bladder as full as it can be.

If the patient survives, the subsequent condition is not always the same. Sometimes, as the cord regains its power, micturition takes place involuntarily at regular intervals: the bladder becomes distended, a drop of urine flows into the neck, the stimulus passes up to the lumbar centre in the cord, and as the influence of the brain is not there to strengthen the sphincter, the muscles of the bladder contract and empty the cavity more or less completely. This appears to be the rule in the lower animals, but such perfect recovery of function is rarely met with in man; either from atony of the wall of the bladder (arising from its over-distension), or from the spinal centre never regaining its full power of reflex action, a catheter has generally to be passed at regular intervals, or the bladder must be emptied by pressure over the pubes.

Cystitis is exceedingly common; in some few cases it may be caused, like bed-sores, by irritation of the cord—extreme congestion, followed by intense inflammation, suppuration and sloughing, setting in without any local cause, and attacking kidneys, ureters, and bladder together—but such must be very rare; in by far the majority it is due to the extreme difficulty of taking proper precautions for such a length of time. There is everything to favour its occurrence: the bladder and urethra are absolutely insensitive; their walls, deprived of all opportunity of working, are badly nourished and therefore prone to inflammation; the cavity is never properly and naturally emptied: the mucus which is secreted and which lines the urethra is not washed out, but remains as a tenacious alkaline coating; the constant introduction of a catheter, even when it is perfectly clean, acts as an irritant; the amount of mucus increases; and the acidity of the urine diminishes until every condition that favours the growth of the specific urea ferment is present. If, under these circumstances, it finds its way in, whether by means of the catheter (which is usually the case) or along the mucus of the urethra, or through the kidney, decomposition immediately begins, the urine becomes ammoniacal, every drop as it falls into the bladder becomes an intense irritant, and the most severe cystitis, so bad as to cause sloughing of the mucous membrane, or perivesical suppuration, is sure to follow. In a large number of the cases in which the patient escapes hypostatic congestion, this proves fatal, either directly or through the secondary inflammation, suppurative pyelo-nephritis, set up in the kidneys.

Priapism is common in fractures above the mid-dorsal region: sometimes it is immediate; more frequently reflex, not beginning until a catheter is passed or the bladder becomes distended. It is rarely marked in degree; and, if the patient survives, usually passes off of itself; occasionally, however, it is extreme and it may be followed by extravasation into the erectile tissue.

As a rule in these fractures the alimentary canal suffers very little; obstinate vomiting has occasionally been noticed in injuries of the cervical region; and tympanites may occur, possibly from absence of the natural support to the intestines after the muscles of the abdominal wall are paralysed. Wherever the fracture takes place, constipation is the rule, so long as the motions are solid: the peristaltic action of the intestine is in abeyance for some time, then it gradually recovers, and at long intervals passes on the contents into the rectum; the sphincter is completely paralysed, and as soon as the lower part of the bowel is reached evacuation takes place involuntarily. Liquid motions, as when there is diarrhœa, flow away continuously without control. In those instances in which the patients recover the bowels usually act once or twice a week, the motions being very copious and solid; and after a time the patient becomes aware, from a feeling of headache, or oppression, or from flushing of the face, when an evacuation is going to take place.

In by far the majority, fracture of the lower cervical spine is fatal within the first four days; few last out the week; a very small number is recorded as having survived for longer periods. Still it is possible for life to be prolonged for months and even for years, in spite of paralysis of the trunk and legs, and in one or two instances of the arms as well. The nutrition of the paralysed part is very feeble; bed-sores are liable to form upon the sacrum, the ischial tuberosities, and the trochanters. If they occur within the first few hours, they may be the direct result of irritation of the cord, but much more often they do not make their appearance until three or four days have passed, and are due entirely to local causes. The body lies absolutely motionless, hour after hour, pressing upon the same points, without intermission of any kind or sense of discomfort; the skin becomes red; the epidermis is detached, the cutis exposed, and a slough soon forms, spreading perhaps until the bone beneath becomes necrosed, or even the spinal canal is opened. If the parts are allowed to become wet or sodden from fæces or urine, this is sure to occur, and the inflammation is very likely to end fatally.

All over the paralysed part the skin becomes harsh and branny, covered with desquamating scales; the rounded outline of the limb disappears, the bones become prominent, the muscles waste and become hard and unyielding, and the limbs are either fixed in a condition of permanent flexion, or are subject to constant twitchings, which may be so violent as to shake the whole body. As may be imagined, the health soon begins to fail, though in fractures through the dorsal region the nutrition of the rest of the body is sometimes maintained surprisingly well; and even if the patient escapes the immediate consequences of the injury, he is very likely to succumb to the first trivial accident with which he meets, even a mere cold, especially if it attacks the lungs.

Injuries of the Dorsal Region

The symptoms of fracture below the first dorsal vertebra are practically the same, making allowance for the difference in position and number of the muscles that are paralysed. Owing to the small size of the canal, the cord is generally crushed completely; there is the same risk of cystitis and bed-sores; priapism, however, does not occur unless the injury is high up; the temperature is rarely phenomenal; and respiration is not so much interfered with. The extent to which this takes place depends upon the number of intercostals paralysed. Temporary recovery is not unfrequent, but death follows sooner or later from bladder or renal trouble, from bed-sores, exhaustion, or from degeneration and softening extending farther up the cord.

Injuries of the Lumbar Region

The lower the injury the better the prognosis: the shock is not so great, the respiratory muscles escape, and, owing to the flexibility and toughness of the nerves that form the cauda equina, the loss of motion and sensation in the parts below is often incomplete. In fractures through the last dorsal or first lumbar vertebra, the centre that governs the act of micturition is destroyed, and the effect on the bladder is the same as if all the nerves going to it were cut across. At first there is retention of urine, and, unless relief is given, overflow, just as when the cervical cord is hurt; but in a short time the muscles begin to degenerate and contract; they become hard and lose their elasticity; the capacity of the bladder diminishes until its cavity is almost obliterated; and a condition of true incontinence is produced, the urine flowing out from the urethra as it passes down the ureters. The effect on defæcation is not so marked, as the action of the intestine is to a much greater extent independent of the spinal cord.

When the fracture occurs below the second lumbar the symptoms are often obscure. The cord itself of course escapes, being above the seat of injury; so may the long flexible roots of the cauda equina, which slip to one side or the other out of the way; and there may be either no nervous symptoms of any kind, or partial loss of motion and sensation, with violent pain shooting down the limbs, owing to some of the nerves being crushed or torn by the broken fragments of bone. If the fourth sacral is injured, there is true incontinence, as when the micturition centre is destroyed. These cases of latent fracture not unfrequently escape diagnosis; there is no crepitus or undue mobility, nor of necessity is there any deformity; merely local pain and tenderness, and a great sense of weakness and insecurity when an attempt is made to stand or move. The prognosis, of course, is much more favourable; but, as in fracture of the spine elsewhere, there is always the risk of chronic inflammation setting in and extending along the membranes until the cord becomes affected.

Treatment.—In many cases the cord is completely crushed at once, beyond all hope of recovery; sometimes the injury is made very much worse by the ill-advised efforts of assistants. If therefore there is the barest suspicion of such an accident, the patient should merely be laid perfectly straight upon his back on level ground and not raised or moved until there is some one to superintend his being placed upon a stretcher. A water or air-cushion, circular or horseshoe-shaped for choice, is essential for the sacrum, and is better than a water-bed; and the mattress and draw-sheets must be arranged so that the bed-pan may be used without disturbing the patient. The outer clothes and boots may be removed while the patient is on the stretcher; the others should be left until he is lifted on to the bed and everything is ready for a complete examination.

Active treatment is impossible in the majority of instances; if, however, definite displacement can be made out, if there is a distinct irregularity in the spines, or a projection where there ought to be a hollow, and if the patient's condition admits of it, reduction should certainly be attempted, and as soon as possible; delay only increases the risk of hæmorrhage and softening of the cord from pressure; but, particularly in the cervical region, it should be explained to the friends that the proceeding may prove immediately fatal.

In unilateral dislocations of the neck, when one articular process only is displaced, and when the accident is the result of some sudden twist, reduction is often attended with conspicuous success. The patient should be cautiously placed under an anæsthetic, so as to relax the muscles; the head, which already inclines towards the opposite shoulder, bent over as far as it can be to disengage the processes; and then rotated so as to carry the under side forwards. Slow extension with rotation has succeeded even without an anæsthetic, the patient being seated and the operator standing behind, grasping the head while the shoulders are fixed; sometimes a sudden snap has been heard; more often the improvement is gradual.

Bilateral dislocations are very much more serious, owing to the displacement of the body; but even here a sufficient degree of success has occurred to warrant the proceeding. Hüter recommends the same method as in the unilateral form, one side being reduced first, and then the other, on the ground that extension when all the ligaments are so much torn would expose the cord to undue risk; and in one case out of three he succeeded in saving life. Ashhurst, however, gives particulars of several in which permanent improvement followed gentle extension combined with rotation, and in one instance with pressure upon the displaced body from the interior of the pharynx. When the displacement is not reduced, the result is almost sure to be fatal within the week. It must always be remembered, in manipulating, that the upper fragment is displaced forwards, and that, if it is carried ever so little farther in this direction, the cord must be crushed. As soon as the displacement is rectified, the head must be fixed by weight-extension, and the arch of the neck supported from below, either by a sand-bag (others being used to prevent lateral bending) or a collar made from softened mill-board, or, better, from sheets of absorbent cotton dipped in thin plaster-cream.

Extension under anæsthetics, combined with pressure, has also been successful in injuries of the lower dorsal and lumbar regions; but the displacement is seldom completely rectified, owing to the presence of fracture and to the locking of the articular processes. Crepitus has been felt on several occasions while it was being done. Weight-extension should be applied to the legs before the patient comes round, in order to prevent any recurrence.

Where there are no nerve-symptoms the trunk may be encased at once in plaster-of-Paris, as the best method for ensuring rest and guarding against injury to the cord; and the same plan has been adopted with great benefit in injuries of the lumbar region in which the displacement has been rectified. Berkeley Hill has done it within thirty hours of the accident: in most of the other cases two to four days have been allowed to elapse.

In the earlier cases the vertical position was tried, the patient either being supported under the arms, or, better, laid upon a table swinging upon a central axis like a toilet-glass, and then carefully slung up from Sayre's tripod. In the more recent ones the jacket has been applied with the patient lying down. A bed is prepared with folded blankets and a macintosh, and two bandages are laid upon it, crossing at right angles to mark the ground plan: one must be long enough to reach from the occiput to within an inch of the trochanters; the other must be one-fourth more than the girth of the patient's chest. On these are placed, first, a many-tailed bandage made of coarse house-flannel to go on the outside of all; then a layer of crinoline bandages, threefold thick, soaked in mucilage and plaster (the proportions are generally an ounce of mucilage to a pound of plaster). The upper strips must be laid in position first, and each must overlap the one above it at least two-thirds. Then, over this in a similar manner, a second and a third layer, the ends of the strips being prevented from sticking to those above and below by laying a piece of ordinary bandage over these down each side. Over all is laid a sheet of absorbent wool, especially thick on either side of the spine, so as to protect the processes as far as possible; and a small water or air-cushion may be fixed opposite the sacrum, so that when the jacket is set its contents may be let out, and it may be withdrawn without disturbing the rest. If the jacket is sufficiently long to come well over the glutæal region, and clasp the crests of the ilia, it will hold the trunk firmly enough.

The patient must be lifted up from either side, carried over the foot of the bed while extension is still being kept up, and laid gently down in the exact position that has been prepared for him; and then, commencing from below, each strip must be carefully folded round, crossed over, and smoothed down as rapidly as possible.

In a very large proportion of cases all that can be done is to protect the patient from the various complications that may set in. The effect of the pressure on the back must be avoided as far as can be by water-cushions and pillows, and by pads of elephant plaster. The skin must be kept as dry as possible, and, whenever there is an opportunity, should be sponged over with spirit to harden it; but care must be taken that the shoulders are not rolled over first to dry that part of the back, and the hips afterwards. Even the position of the extremities must be carefully watched, and the weight of the bed-clothes prevented from pressing them down, or sores may form upon the external malleoli and elsewhere. The bladder must be emptied by means of a catheter three times a day; of course the greatest gentleness must be used, especially as the part is absolutely insensitive; but this is not enough, the catheter must be of the softest description, and must be kept in a solution of carbolic; it is not enough to dip it in before using. If there is the least sign of cystitis, gr. xv. of benzoate of ammonia should be given three times a day to try and keep the urine acid; the bladder should be very carefully washed out with Condy's fluid, boracic acid, or a very dilute acid solution of corrosive sublimate; and a grain of sulphate of quinine dissolved in an ounce of water may be injected afterwards and left in. Phosphatic calculi of enormous size have formed in the bladder after fracture of the spine. The bowels are better left alone, at first, at any rate; the amount of food the patient takes is generally very small, and the inconvenience of constipation is not to be compared with the risk of movement and the danger to the skin. Care, however, should be taken that the anus and the parts around it are kept dry. If the bowels do not act of themselves after a few days, an enema may be given.

Pain shooting down the nerves is sometimes relieved by continuous extension; the hyperæsthesia that sets in on the second day and occasionally extends over the non-paralysed portion of the trunk is more difficult to treat. Probably it is the result of hyperæmia of the cord and points to the commencement of red softening or myelitis. Iodide of potash in large doses has been recommended, and leeches have been applied with advantage when the injury was in the lumbar region, so that the bites would not afterwards be pressed upon; but the prognosis when this sets in is very grave.

In cases of fracture by indirect violence the operation of trephining offers little or no hope. It is probable that in the majority of cases the cord is only subjected to momentary compression, but yet it is so reduced to pulp that recovery of function very rarely follows. If it were possible to diagnose the persistence of compression and to relieve it by operation, the condition would be no better and the probability of recovery not in the least greater. This has been confirmed by actual trial in a sufficient number of instances; in fractures of this description the injury to the nerve structures is either so slight that an operation of such a nature is not justifiable, or so severe that it could do no good.

In fractures by direct violence, on the other hand, the question is altogether different. A lamina or a spine may be driven in with just sufficient violence to compress the cord without destroying it; and if anything of the kind is suspected, the operation should certainly be performed at once. It has proved its merit. Still more is this the case with the cauda equina. The nerves that compose it may be compressed by displaced bone or by cicatricial tissue, and although they possess a power of adapting themselves altogether unknown in the spinal cord, there are limits even to this; and if improvement does not take place, or if in a few weeks it begins to flag, it is open to argument whether it would not be better to expose the seat of injury and, if possible, release them.

Injuries of the Spinal Cord

The spinal cord may be injured by itself without the vertebral column being hurt. It may be bruised from a violent blow upon the back, or torn from forced bending; it may be compressed from hæmorrhage, from bone that has been driven in, or from inflammatory products thrown out by the meninges; it may be so shaken by concussion that its activity is partially suspended, or it may be wounded by stabs or punctures between the arches of the vertebræ. The symptoms are essentially the same as when it is crushed in fractures of the spine; and the same sequelæ, softening and inflammation, may set in, but they differ considerably in their extent and in the time of their occurrence.

Contusion of the spinal cord.—Hæmatomyelia.—Hæmorrhage into the substance of the cord is nearly always the result of forced flexion, and occurs naturally in the region in which fracture by indirect violence is most common. Sometimes the similarity of origin is shown by their occurring together, but independently of each other. It is possible, however, that it may be caused by direct violence also. The hæmorrhage nearly always lies in the grey substance of the cord, because this is the softest and the most vascular part; and it may occupy an indefinite length. The effect is immediate, becoming intensified later as the hæmorrhage extends. Motion and sensation are lost over a corresponding area ; reflex action is suspended for a time, but rarely so completely as when the cord is crushed ; and then later, as the circulation around the injured area becomes more active, hyperæsthesia sets in ; motor disturbances are rare.

The subsequent course depends chiefly upon the degree of the primary injury. The extravasated blood may be in great measure absorbed, leaving a certain degree of anæsthesia, with paralysis or spastic rigidity of the muscles, corresponding to the part of the cord that has been destroyed ; or, on the other hand, red softening and ascending myelitis may follow, the paralysis extend higher, bed-sores and cystitis set in, and, if the injury is in the cervical region, phenomenal temperatures, just as when there is a fracture. According to Thorburn it is probable that cases of hæmorrhage into the cord are much more common than is usually suspected.

Wounds of the spinal cord are rare in civil practice, but they may be produced by stabs, the weapon passing between the arches of the vertebræ, possibly notching or incising them as it does so ; or by gunshot injuries. The symptoms in either case depend upon the seat and the extent of the injury, and only differ from those of crushing of the spinal cord in fractures by their proneness to inflammation and suppuration. There are several authentic cases on record in which men have recovered completely after symptoms that pointed to at least partial division of the cord ; so that it is probable that, though it may not be so perfect as it is in animals, a certain amount of repair may take place, whether this consists in actual reunion of the divided fibres, or in a re-arrangement of conduction in the cord.

Compression.—This is much more rare ; it may be caused by a lamina driven in, though when this occurs the delicate nervous tissue is almost sure to be utterly crushed ; or by hæmorrhage, either inside the theca or between it and the bones (it is impossible to distinguish one from the other) ; or later it may result from inflammation, as in Pott's disease. If due to bone the symptoms are immediate ; if to hæmorrhage, there is a distinct interval before they commence, and they progress from below upwards, affecting the leg first, and then the trunk, until the respiratory muscles are involved. The loss of motion is more marked than that of sensation, but it is rarely so definite as in contusion ; pain along the course of the nerves, hyperæsthesia extending round the trunk, and muscular tremors are more frequent. In many instances the blood is absorbed again and the symptoms subside ; occasionally it accumulates to such an extent as to prove fatal, either from its pressure or from secondary softening and degeneration.

Concussion.—The position of the spinal cord, surrounded by a water-bed and suspended by the nerves and the ligamentum denticulatum in the centre of a flexible column of bone, which nowhere presents any large surface exposed to injury, is such that concussion, by itself, must be very unusual. If the term is used in the same sense as in speaking of the brain, it can only be caused by direct violence ; the symptoms must be immediate ; there must be no gross lesion, merely suspension of activity for a time, and then, after a few minutes or some hours, gradual recovery. Practically therefore it occurs under the same conditions as contusion, and can only be distinguished from it by the symptoms being general, not confined to any one portion of the spinal cord, and by their passing off within a few hours. Such cases do occur, though it very rarely happens that there is an opportunity of proving them. Gull (Guy's Hospital Reports, 1858) mentions one of peculiar interest ;

a man, 40 years of age, fell on to his back from a moderate height; immediately after the accident there was partial paralysis of the upper and lower extremities with collapse, but no insensibility. Later in the day, as reaction set in, and the skin became warm again, the paralysis gradually disappeared. The next morning symptoms of injury to the cervical portion of the cord came on; paralysis of upper and lower extremities; anæsthesia; priapism; tympanites; high temperature; and paralysis of the respiratory muscles followed. He died at the end of the third day. *Post mortem* the membranes of the cord and the cord itself appeared entirely uninjured; so that the earlier symptoms can only have been due to concussion: outside the theca, caused by a fracture through the body of the fourth cervical vertebra, was a large extravasation of blood which had gradually extended down the canal and compressed the cord. There was slight displacement of the body of the fractured vertebra, but not sufficient to press upon the membranes.

Afterwards, when the immediate symptoms have disappeared, hyperæmia may set in, as in concussion of the brain. If there is no contusion this may be merely transient, and under proper treatment subside without leaving behind any serious result; but if the part is not kept at rest, or if there is severe contusion, it may increase, and either run on to inflammation or lead to softening and degeneration.

Railway accidents are not unfrequently followed by a peculiar train of symptoms which have been grouped together under a name, 'railway spine,' justly stigmatised by Page as absurd.

The symptoms do not set in immediately and are not those of any gross lesion of the cord, such as contusion or inflammation. As a rule they do not appear for three or four days: then, after lasting some time, they either begin to subside or steadily grow worse. The chief difficulty is to distinguish them from locomotor ataxy and chronic meningo-myelitis, both of which may undoubtedly follow injuries to the back. If, however, sufficient attention is paid to objective symptoms, to the distribution of areas of anæsthesia, for example, and the electric reactions of muscles, it can usually be surmounted.

Railway accidents are always accompanied by an extreme degree of shock. Sometimes this takes the ordinary form of profound collapse from the first; more frequently there is a peculiar phase of unconsciousness associated with excitement; pain is not felt; an enormous amount of energy, often strangely misdirected, is displayed; and then suddenly, some time later, the patient as it were wakes up and is entirely unable to account for himself, or what he has done, or explain how he came to be where he is. This is generally followed by violent reaction, the more intense perhaps for being so long postponed. The temperature falls; the pulse becomes small and feeble; the face is pale; the forehead covered with cold perspiration; there is retention of urine; often the secretion is scanty; in short, the patient lies in a condition of complete prostration.

This may end in various ways.

Occasionally, but fortunately not very often, it grows worse and worse; the patient becomes more feeble, and without being able to assign any definite reason for it or find any gross lesion, death ensues after a few weeks or months, just as sometimes happens after a severe mental shock.

More frequently there is a certain amount of improvement for a time, but not perfect recovery. The extreme depression passes off, but the patient remains weak and feeble, unable to control himself or to exercise deliberate judgment, with mental capacity and bodily vigour alike impaired. The symptoms are of the most varied character. Some, such as palpitation, flushing, alternate sensation of heat and cold, and menorrhagia, may be accounted for by the disorderly working of the vasomotor system; others, like sleeplessness, dreaming, headache (often posterior), irritability of temper, emotional display, noises in the ears, and failure of sight, are due to interference with the blood-supply of the brain and the organs of special sense. Dyspepsia is always present and makes the other symptoms worse. The breath is foul; the bowels are constipated; the bodily strength fails; the patient becomes worn and emaciated; the cerebral symptoms grow more pronounced, and at last he becomes utterly broken down in health, feeble in mind as well as body, and aged before his time.

This is not in any way peculiar to railway accidents. It may be induced by injuries of all kinds, especially in those who from heredity or for other reasons are in any way predisposed to the occurrence of nervous disorders. It is not uncommon, for example, after severe and prolonged mental trouble; it may even follow a single shock; and I have met with minor degrees of it in several of those who were exposed to the earthquake in the Riviera, and in one person after a dynamite explosion. Occasionally it persists for the rest of life; as a rule it passes away by degrees; and, as Page has clearly shown, even when there is no suspicion of fraud, there is often rapid improvement as soon as the irritating question of compensation is settled. Too little is known about the working of the central nervous system to hazard a suggestion as to what really happens in such cases; but there can be no doubt that the brain is involved at least as much as the cord, and very possibly a great deal more.

In another class the symptoms resemble those ordinarily grouped together as hysterical. There may be epileptiform attacks from time to time with insanity, melancholia, or suicidal impulse. Anæsthesia and hyperæsthesia may occur, affecting the special nerves as well as those of ordinary sensation. There may be, for instance, contraction of the field of vision, achromatopsia, or hyperæsthesia at various points; one half of the body may be anæsthetic, or one limb, the line of limitation being circular, not corresponding to the anatomical distribution of the nerves; and occasionally hysterogenic points, pressure upon which causes epileptiform spasms, are associated with these. In other instances muscular paralysis, affecting physiological groups rather than anatomical ones, or spasmodic contraction is present, the electric reaction remaining unaltered. Retention of urine and aphonia are very common; and numerous other symptoms are met with from time to time—pains in the joints, for example, of the most excruciating character, without any objective sign, dysphagia, torticollis, closure of the jaws, &c.

Thorburn has ingeniously attempted to explain these results by a comparison with what takes place by 'suggestion' in hypnotic sleep. There is certainly to all appearance a very close resemblance between the condition of unconscious excitement that so often occurs after these accidents, and some phases of hypnotism: and there is nothing impossible in the idea that the violent shock and emotion at the moment are capable of producing either this condition or one closely similar to it. Now Charcot has shown that in hypnotised persons light blows are often followed by paralysis and anæsthesia, suggestions of them, when there is this condition of profound mental shock, are capable of doing the same.

If in either of these groups of cases there is in addition a severe sprain of the muscles or ligaments of the neck and back, so that every movement is attended with pain, the difficulty of proving that the whole mischief is limited to external structures, and that the spinal cord is not involved as well, may be imagined. The local symptoms, the stiffness, rigidity, and pain, grow worse and worse as time goes on. If the hypnotic state continues, each suggests some further trouble, and it is almost impossible to distinguish between the real and the functional disorder. The desire to get well is often not genuine, even when it is present, and it is impossible to obtain any assistance from the patient. If there is even a suspicion of chronic inflammation of the spinal cord, it is a serious matter to propose active measures. And thus it comes about that time passes by; the muscles become more rigid from disuse; the extravasated blood becomes organised; adhesions are formed in all directions; and it ends in leaving a permanently crippled condition.

The diagnosis from chronic inflammation of the spinal cord rests chiefly upon the absence of definite local signs. Stiffness and rigidity of the back are not leading characteristics of chronic meningitis. When this sets in there are other symptoms, usually of an unmistakable character: there is pain along the course of certain nerves; or anæsthesia and hyperæsthesia of definite regions; special groups of muscles are wasted or paralysed; the electric reactions are abnormal; the cutaneous reflexes are enfeebled or lost; in short, there is definite evidence of injury to nerves or centres in the cord, such as does not occur in sprains of the vertebral column alone, however severe the mental depression and bodily weakness may be.

Section III.—Diseases of the Back

DISEASES OF THE SPINAL COLUMN

Ostitis

Inflammation of the vertebræ is nearly always tubercular, in children almost without exception, although it is not impossible that the immediate starting-point of the disease is some slight injury causing an extravasation of blood into the substance of the cancellous tissue. In exceptional cases it may be due to syphilis (perhaps more frequently than is suspected, in the case of adults), and late in life to rheumatism, osteoarthritis, and ostitis deformans.

Tubercular Ostitis

This is essentially a disease of childhood, although it may occur at any period of life. Sometimes it is excited by injury and affects one part of the spine only; more rarely several vertebræ are involved together. Like tubercular ostitis elsewhere, it nearly always begins in the cancellous tissue, where growth is most rapid, and the blood-supply most abundant. The upper or under surface of the bodies or the anterior border is the favourite seat; the spinous and transverse processes are never involved at the first, although later they become welded together as the inflammation extends to them; and the articular processes only when, as in disease of the atlas and axis, synovitis precedes ostitis.

The most common situation is at the junction of the lumbar and dorsal regions; here the bodies are large, and strains are felt most severely. The cervical vertebræ enjoy much greater immunity, and the two highest, in children at least, the greatest of all. There is some reason to think that disease of the atlas and axis is proportionately more common in adults.

Usually the intervertebral discs are destroyed with the bones between which they lie, the granulation-tissue eating into them and causing their gradual absorption. Sometimes they disappear at a very early period, as if the force of the disease was spent on them rather than on the bodies; very rarely they persist, as when the vertebræ are absorbed by the pressure of an aneurysm.

Pathology.—This does not present any special feature. The disease begins as rarefying ostitis, the bone becoming softer, more open and vascular, and the bone-corpuscles undergoing fatty degeneration. According to the intensity and number of bacilli on the one hand, and the strength and resisting power of the tissues on the other, resolution, caseation or liquefaction follows.

In the most fortunate everything is restored: the bacilli are killed or removed by the tissues and recovery is complete. In others not so good the process steadily advances without any caseation (caries sicca or fungosa) until the solid structure of the spine is replaced by masses of soft granulation-tissue, which yield and give way beneath the weight of the trunk. In others again the centre slowly degenerates, caseates, and becomes liquid, forming a so-called caseous abscess, filled with serum, mixed with broken-down particles of bone and cheesy débris. Sometimes, when the inflammation is severe, fair-sized sequestra are found as well (caries necrotica). Even then recovery is possible, with more or less deformity. Part of the débris is absorbed, the rest undergoes calcification; the vertebræ fall together, and anchylosis occurs (fig. 287). On the other hand, however, the caseous focus may extend, grow larger and larger, until somewhere it approaches the surface, breaks, and unless due precautions are taken, becomes infected with pyogenic germs as well.

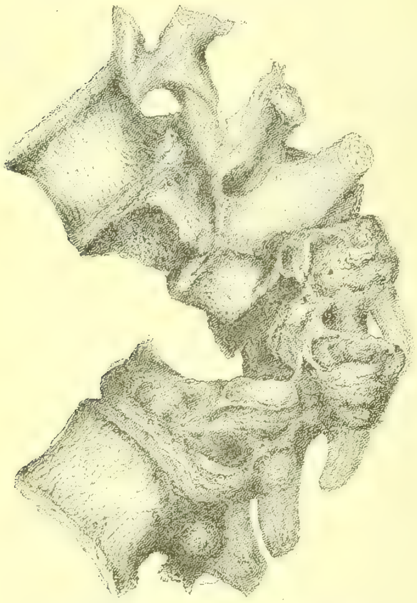


FIG. 287.—Anchylosis of dorsal vertebræ, with great deformity consequent on caries of the the bodies.

Disease of the upper two cervical vertebræ nearly always commences as synovitis and extends from the articulation to the bone beneath, spreading along the most vascular lines, and therefore, if it involves the axis, separating the odontoid process from the body.

The deformity depends upon the amount of destruction. If the caries is superficial, involving only the anterior surface of the body, and if repair begins at once, it may be entirely wanting. If the bodies are softened or destroyed, even if only part of one, the spine above sinks forwards, the spinous processes project backwards, and compensatory curves in the opposite direction are developed above and below. This is most distinct in the dorsal region; the lower cervical rarely becomes convex backwards, only a little thickening is perceptible, and the lower lumbar practically cannot. Disease between the axis and atlas is peculiar again in this: for, owing to the shape of the articulation on the former, the latter, when the ligaments are softened by inflammation, or the odontoid process is detached from the base on which it rests, slips bodily forwards, carrying the head with it, so that when the patient is looked at from one side it appears as if the head were placed in front of the spine.

The effect of this displacement (when it is below the third cervical vertebra) on the diameter of the spinal canal, is exceedingly slight; often it is actually enlarged; exceptionally a wedge-shaped portion is driven backwards (fig. 288) into the substance of the cord. When the upper two, however, are concerned the atlas slides forwards, and the antero-posterior measurement opposite the odontoid process may be reduced to less than half an inch. This, if it is effected gradually, is not incompatible with life, and the odontoid process may even become anchylosed in its new situation as much as half an inch in front of its natural one (fig. 289).

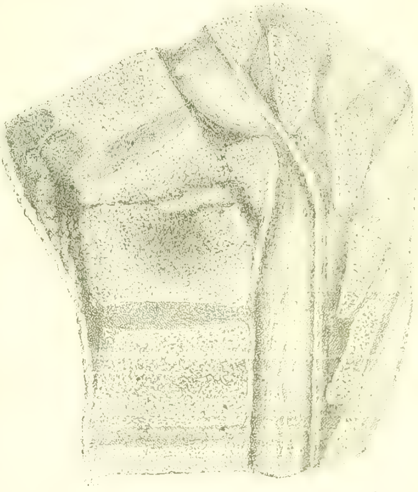


FIG. 288.—Tubercular ostitis with caseation under the anterior ligament and in the bodies of the vertebræ. A triangular sequestrum has been driven back so as to compress the spinal cord.

The deformity cannot, of course, remain limited to the spine. When the cervico-dorsal region is affected, the chin is brought down on to the sternum so that the movements of the neck cannot be carried out; and similarly when the curvature is lower down the thorax is crushed together, respiration is carried out by the diaphragm only, and the heart and the abdominal viscera are placed at great disadvantage.

Repair may commence at any time; the caseous material, if any has formed, and the débris being absorbed, dried up, or discharged externally. The vertebræ above and those below fall together; the spines, laminæ, and in the dorsal region even the ribs, become welded into a solid mass; the sinuses gradually close up, and bony splints are thrown out around in proportion to the degree of strength required.

Suppuration is visible, according to Golding Bird, in about five-and-twenty per cent. Probably caseation and liquefaction are present in many more, but do not come to the surface. The fluid may make its way into the spinal canal and spread down it, outside the theca vertebralis; but much more generally it comes to the front, under the anterior common ligament, and then spreads outwards. If the cervical vertebræ are diseased, the abscess may point in the pharynx (retropharyngeal); in the posterior triangle of the neck just above the clavicle; or, especially if the lower one or two are concerned, it may extend down into the posterior mediastinum. From the dorsal vertebræ it usually makes its way behind the pleura into the sheath of the psoas, destroying the muscle, dissecting out the nerves of the lumbar plexus, and pointing below Poupart's ligament, on the inner side of the femoral vessels. Sometimes, however, it turns round, accompanying branches of the intercostal vessels, and passes between the transverse processes to the skin of the back. In the case of the lumbar vertebræ it may either follow the same route or work its way into the pelvis, from which it escapes either above Poupart's ligament in the iliac region, or along the rectum in the ischiorectal fossa, or, accompanying some of the branches of the internal iliac, out through the sacrosciatic foramen.

In the later stages, especially after liquefaction has occurred, the inflammation not unfrequently extends to the dura mater and even to the spinal cord. Sometimes a mass of granulations, developed from the posterior surface of the vertebræ, presses against the theca; more frequently meningitis sets in, and the membranes become thickened, caseous, and adherent to each other and the cord beneath; occasionally the cord itself is involved, and the degeneration spreads upwards and downwards in its substance, until it is practically disorganised.

The most common cause of death is septicæmia, hectic, or amyloid disease, consequent on suppuration; but it may occur from tuberculosis, affecting the meninges, or disseminated; from pressure upon the cord itself (especially in atloaxoid disease); or from the secondary consequences of paraplegia. In other cases it follows indirectly from the distortion of the thorax caused by the angular curvature, long after the disease itself has come to an end.

Symptoms and diagnosis.—It is of the utmost importance to diagnose caries of the spine before it has caused deformity. There is then fair prospect of recovery, and if taken in time repair may be perfect. Deformity, once established, is irremediable.

The most prominent symptoms are pain, tenderness on pressure, rigidity of the back, and a sense of weakness which, even when the child cannot describe it, can usually be recognised from its actions.

Pain is rarely local; nearly always it is referred to the distribution of the spinal nerves, not their origin; thus, in atloaxoid disease, it is felt over the back of the head, or, when the dorso-lumbar region is concerned, over the pubes. Sometimes there is a sense of constriction round the thorax; and children often describe it as stomach-ache. Usually it is worse after standing or any exertion; lying down, it may not be felt at all. It is a rough but a sure test for the absence of spinal caries to stand a child on the seat of a chair and tell it to jump down: if it comes down readily and fairly on its feet from a height of only a few inches, ostitis is out of the question.

Tenderness on percussion is very important, especially in adults; a smart tap with the finger on the tip of the spinous processes will generally show whether there is any inflammation. Not unfrequently the skin covering the same region is hyperæsthetic, especially to temperature, owing, in all probability, to the distribution of the posterior divisions of the spinal nerves, for the same thing may be noticed over the insertions of strained and overworked muscles.

Muscular rigidity is highly characteristic: every movement of the segment of the back for some distance above and below the seat of mischief is avoided with the greatest care. If the cervical spine is involved, the whole trunk is turned round instead of the head when the patient wishes to look to one side, and it is done with the utmost deliberation. If it is the back, and a child is told to pick up anything from the floor, the hips and knees are bent, the head is thrown back, and the spine kept absolutely rigid. Sometimes it voluntarily goes on hands and knees. For the same reason the walk is very peculiar, entirely different from the natural mobile gait, and wry-neck and other distortions are not unfrequently present.

Where children are concerned *the weakness of the back* must be judged of by their actions. They cease to play and run about; they wish to be left alone quietly; and if they must stand, they try to support the weight of the head and shoulders by resting their hands upon the furniture or even upon their knees, propping themselves up in a crouching attitude. With adults it is more easy, as they can explain the peculiar difficulty they experience in holding themselves upright.

Early diagnosis is often a matter of real difficulty, particularly in the case of children. In many cases it is advisable to act upon the safe side and confine them to bed for a few days. Wry-neck, for example, arising from strains, inflamed glands, cold, or reflex irritation, may simulate the beginning of cervical caries very closely; but, as a rule, a few days' rest is sufficient to make the distinction clear, and can do no harm. The danger is that the earlier symptoms may be overlooked and regarded merely as growing pains or stomach-ache.

With young adults, particularly girls, hysteria is the chief difficulty; and it must always be recollected that even when some of the symptoms are transparently exaggerated, there may be real disease behind. The projection of the lower cervical vertebræ is a frequent source of alarm, especially as it is sometimes greatly increased by muscular weakness or from some habitual faulty attitude. Fortunately the symptoms generally exhibit such discrepancies that, if not at the first examination, at least after two or three, the existence of caries may be negatived without fear.

The diagnosis is much easier when *deformity* is present; but the disease may be far advanced before it makes its appearance; and, as just mentioned, care must be taken not to mistake natural projections for pathological ones (see Angular Curvature).

Caseation and liquefaction may occur, even though deformity is never present, and no case of spinal disease should be allowed to pass without investigating all the ordinary situations.

Retro-pharyngeal abscess usually first attracts attention by the difficulty it causes in breathing and swallowing. Generally it lies rather to one side of the middle line and is accompanied by an ill-defined swelling near the angle of the jaw: in some cases fluctuation can be felt across from one point to the other. Left to itself it may burst into the back of the pharynx (it has been known to cause suffocation from entering the larynx); or work its way into the mediastinum; or point on the side of the neck. Large fragments of the atlas and axis have been discharged through the opening in the pharynx in many instances.

Dorsal or lumbar abscess forms a soft fluctuating swelling on the outer side of the erector spinæ. Not unfrequently it is divided in two by a band of fascia, and often it is only the superficial part of a much larger cavity in the psoas and can be considerably reduced in size by steady pressure. The diagnosis usually presents no difficulty; but it must be distinguished from subcutaneous abscesses, hæmatomata, suppuration in connection with the ribs, empyema, nephritic and perinephritic abscesses, pyonephrosis, hydronephrosis, hydatids and soft elastic sarcomata originating in connection with the bones or the kidney.

Psoas abscess when the abdomen is thin, as in a child, can be felt under the linea semilunaris as a soft ill-defined swelling by the side of the spine. The hip is flexed, the thigh adducted, and not unfrequently there is severe pain along some of the branches of the lumbar plexus. In other cases it remains latent and even unsuspected throughout. There is no limit to its size, and its shape presents infinite variety. It may work its way out under Poupart's ligament behind the vessels and point to their inner side in the adductor region; or the fascia may give way in other parts and offshoots spread into the iliacus, down the opposite psoas, into the pelvis (coming out through the perinæum or the sacro-sciatic foramen), or down the thigh on its outer side near the tensor fasciæ femoris. It has even been known to extend into the inguinal canal and down into the leg.

True psoas abscess may occur independently of bone-disease, after injury (though it is not unlikely that many of these cases are really due to superficial caries); or from inflammation of the hip-joint, or of the bones of the pelvis. Other abscesses are met with in the same region in connection with the lymphatic glands, the cæcum, kidney, and even the pleura; and sometimes pelvic cellulitis works its way upwards as well. In addition it must be distinguished from femoral hernia, bursæ, or cysts, such as develop occasionally in connection with the hip-joint, and soft rapidly-growing tumours springing from the bone, lymphatic glands, or cellular tissue. Its chief diagnostic feature is the ease with which it can be made to disappear by gentle steady pressure when the patient is lying down, and the gradual way in which it fills again. Sometimes the neck is so wide that there is a distinct impulse on coughing, and not unfrequently fluctuation can be made out between the intra and extra-abdominal parts.

Spinal paralysis, like suppuration, may begin at any period, although naturally it is more common in the later stages of the disease. Loss of motion always precedes that of sensation, and may be nearly complete without the latter being seriously impaired. The gait becomes shuffling; the movements of one or more of the limbs are awkward; and the loss of power becomes more and more evident, with a certain degree of numbness, until at length complete paraplegia follows. So long as the cord is merely compressed the patient may retain power over the rectum and bladder, but this too is not unfrequently lost in the later stages. When myelitis sets in there is often severe pain along the course of the spinal nerves, with spasmodic muscular contraction; the skin becomes dry and branny; all power of the sphincters is lost; the limbs are wasted, the joints generally speaking flexed, and the muscles rigid and not unfrequently thrown from time to time into violent spasmodic contractions from the uncontrolled reflex irritability of the spinal cord. Occasionally the inflammation suddenly becomes acute and extends upwards, with symptoms of high fever, to the meninges of the brain.

In disease of the cervical spine respiration may be seriously endangered either from displacement forwards of the atlas and cranium upon the axis (fig. 289), or when the disease is lower down from gradual flattening of the cervical curve, owing to the softening of the ligaments. Under these circumstances any sudden movement of the head, either forwards or backwards, or even lying in the supine position without a support beneath the arch of the cervical spine, may cause immediate asphyxia.

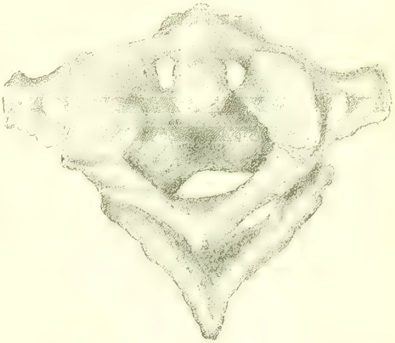


FIG. 289.—Separation of the odontoid process by caries, anchylosis of the detached part to the atlas, and reduction of the spinal canal to a narrow chink.

The peculiar carriage of the head, which is held perfectly rigid in one position (generally poking forwards or to one side, but occasionally dragged back); the pain along the course of the spinal nerves, especially the great occipital; the spasmodic contraction of the muscles of the neck; and the pain when any pressure is made on top of the head, are the most important of the early signs of disease of the upper cervical vertebræ. Many of these may occur together under other circumstances, when, for example, the muscles of the neck have been strained, or when the cellular tissue or the lymphatic glands lying between them are inflamed; and it may be almost impossible at first to make a certain diagnosis.

Treatment.—The general principles have been described already under the head of tubercular ostitis. With very few exceptions local removal of the diseased portion is out of the question; all that can be done is to improve the general health and subdue the local inflammation, in the hope that the tissues may be able to cope successfully with the disorder.

Rest is the first consideration. In most cases it is advisable to confine the patient, for a time at least, to the recumbent position, on a well-made hair mattress with sand-bags as splints. In disease of the upper cervical vertebræ it is absolutely essential, a bag being placed on either side, coming well down against the shoulder, and a third smaller one under the arch of the spine. If the patient's circumstances are favourable, this may be kept up for many months without the least deterioration of health; indeed, distinct improvement is not uncommon, especially when the pain has previously been severe. Later, when the acute symptoms have subsided and the tenderness on pressure has disappeared, the back may be encased in some kind of splint, and the patient allowed very gradually to begin to move about.

Unfortunately this is not practicable in the majority of cases, although an attempt should always be made to secure a prolonged rest at the commencement. Even with a splint, however, very great success may be obtained, if only the patient can be kept quiet, supplied with good food and fresh air, and made to lie upon a reclining chair the greater part of the day; but with children, particularly in the poorer classes, in whom this disease is so common, the difficulty is almost insuperable.

The splints in common use are made of plaster-of-Paris (Sayre's jacket), poroplastic felt, or metal. Of these the first is by far the cheapest, and is especially useful for children, in whom the weight of the body is light and the bony prominences well defined. For older patients, and particularly women, it is not nearly so suitable; the weight of plaster is too great, and the fit is not so accurate or close. The disadvantages are that it cannot be used where there are suppurating sinuses, and that it cannot be taken off. A well-made jacket will always last three months and sometimes six, although for the sake of the development of the thorax it is never advisable to leave it on so long; but the objection to many people is quite insuperable.

Poroplastic felt is more expensive and does not fit so well; but it is much lighter; it can be taken on or off with ease; and if very great strength is required at any spot, strips of metal can be fastened to it. Its chief use is in the later stages, when only general support is required; and it is best to obtain it roughly fitted to the shape of the trunk already, so that there is no difficulty in moulding it. Moist or dry heat may be used to render it flexible for the time; but if any parts are required permanently soft, as, for example, over the breasts, they must either be left so in the manufacture or the resin dissolved out afterwards. It is fastened in front with straps and buckles, one side overlapping the other considerably; and in taking it off it must be rotated through a quarter circle first, so that the thorax may slip out sideways.

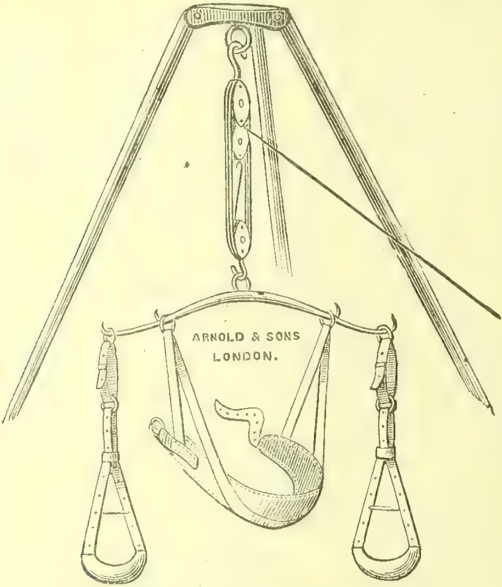


FIG. 290.—Apparatus for applying Sayre's jacket; consisting of tripod, pulleys, and suspension supports for arms and chin.

Metal supports are very much more expensive, requiring skilled labour and of short but stout and heavy people, they are the only ones of real service. They consist of a metal girdle which can be buckled round the pelvis; two uprights, one on each side, carrying crutches, partly for the support of the shoulders, partly to prevent the drooping forwards of the upper part of the trunk, and to give a point of fixed resistance for straps; and of a single or double support in the middle line behind, fitted to the spine, and capable of being made to press either forwards or to one side by means of a ratchet arrangement. In many cases it carries lateral plates as well, so that when the patient stands upright and the body sinks down against them, a large part of the weight is transmitted directly to the pelvis. These do not of course secure the same amount of rest as a well-made plaster splint, but special modifications suited to individual cases may be devised much more easily.

Sayre's jacket is applied to the patient while in the vertical position, slung from the head and shoulders (fig. 290). A specially made collar is fitted under the chin and the occiput, and two well-padded straps under the arms. These are fastened at a proper height and at a proper distance from each other to a horizontal cross-bar, which in its turn is suspended in the centre of a tripod stand, and is so arranged that it can be raised or lowered at once without any jerk. The patient is first fitted with a sleeveless merino vest, fastened on top of the shoulders and coming down well over the crests of the ilia. Except in children with very flaccid and prominent abdomens, a pad of suitable size should be slipped in from below, between the vest and the stomach, and withdrawn when the jacket is dry; and in females similar smaller ones may be used for the breasts. Any special bony prominence should be protected by surrounding it with a ring-pad outside the vest, to be left permanently. The bandages are made of very coarse crinoline muslin torn into strips about four inches wide; and the plaster is well rubbed into the meshes as they are rolled. If it is not perfectly fresh it should be re-baked, or a little alum may be added to the water. The bandages are placed under water, standing on one end, one at a time, a second being put in as the first is taken out.

As soon as everything is ready the patient is gently raised until only the toes rest upon the ground; there is no object in swinging clear, and sometimes it causes considerable alarm. As a rule, if there was any pain before, it disappears at once, and if the straps are properly arranged most patients describe themselves as perfectly comfortable. The effect is not to straighten out the curve, that would be most undesirable, but to fit the jacket to the trunk while in its best position, with the thorax expanded. When the patient is lowered the ribs and the scapulæ sink down and are fixed by the weight of the body against the inner wall. The first bandage is applied round the hips; and then successive turns are carried round the abdomen and thorax, without making any reverses, until the body is encased sufficiently strongly, from the armpits to three-quarters of an inch below the iliac crests. An assistant in the meanwhile smooths the surface down, and if there are any inequalities rubs a small quantity of plaster in. In adults, where great strength is required, strips of tin may be inserted here and there. When the casing is finished the patient is gently lowered to a horizontal position by bringing up behind him a vertical table swinging on a central transverse axis and provided with cushions, so that there may be no strain until the plaster is thoroughly set. Afterwards it may be trimmed down under the arms, and over the iliac crests if it descends too low. The movable pads are pulled out as soon as the casing is firm.

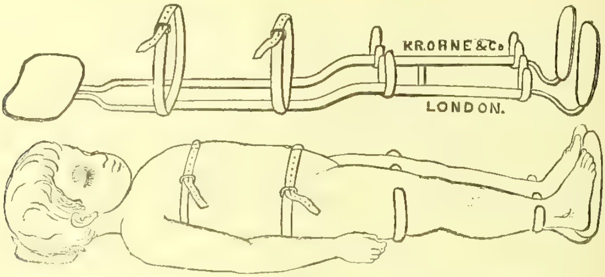


Fig. 291.—Double Thomas' splint for caries of the neck.

In disease of the cervical or cervico-dorsal vertebræ absolute rest is essential, until it is certain that the acute symptoms have subsided and the period of consolidation is well established. The patient lies perfectly flat with the head and shoulders fixed by means of sand-bags; and, as already mentioned, care must be taken to preserve the contour of the spine. Afterwards some kind of appliance must be fitted to keep the head and neck at perfect rest.

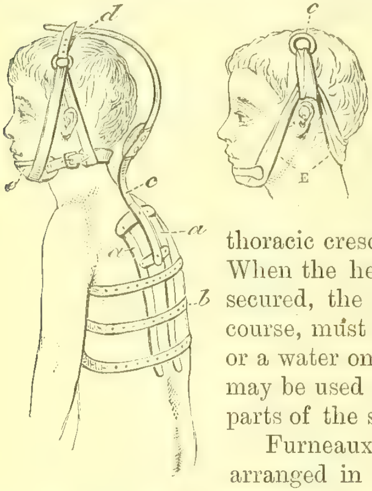


Fig. 292.—Sayre's jury-mast.

The most useful is the modification of a double Thomas' splint devised by Krohne (fig. 291). In this there is an upright on either side, coming from the thoracic crescent and supporting a pad for the occiput. When the head is fastened to this and the trunk is well secured, the immobility is complete. The patient, of course, must have either an exceedingly soft feather-bed or a water one for lying down. This form of apparatus may be used with great advantage in disease of other parts of the spine as well.

Furneaux Jordan recommends plaster bandages arranged in a figure-of-eight for cervical caries. The centre of the upper loop is on the forehead: from this the bandage passes on either side above the ears, downwards on to the opposite scapula, and beneath the axilla, round the thorax. The jury-mast arrangement of Sayre (fig. 292), however, is better than this, especially when the disease is below the axis, as it permits a slight degree of rotation, and exerts a little steady extension. It consists of a metal rod, fastened below in the meshes of a plaster jacket, exactly opposite the spine, and curved so as to follow the outline of the neck, pass round the occiput and end on the top of the head. To this is attached a collar which supports the chin and the occiput, the degree of tension exerted by the metal being controlled by straps and buckles; a similar apparatus may be secured to a poroplastic jacket.

Suppuration in connection with Spinal Caries

As a rule, abscesses should be opened early and freely: leaving them, in the majority of cases, only enables them to become larger and more complex in shape, and an imperfect incision is a premium on putrefaction. Aspiration is of little service, although occasionally in young children, when the condition is in other respects improving and the abscess is not increasing, it may be tried once, or even twice, in the hope that by reducing the tension, absorption may be set up. No attempt should be made to empty the abscess, and very slight suction should be employed, for fear of causing hæmorrhage from the granulations. As a rule, if it is used more than once or twice the opening fails to close, a little serum drains away, the skin becomes ulcerated, and the contents discharge themselves slowly and intermittently.

Where it is practicable, a spinal abscess of any size should be opened in two places, one of which should be at the lowest point. If the interior is very irregular in shape, divided into numerous pouches by stout bands of fascia passing across it (such, for example, as Poupart's ligament), it is of great advantage, wherever it is possible, to make an opening into each. The object is not only to empty it of its contents, but to keep it empty, and this is impossible with a complicated cavity, altering in shape with every movement of the body, if only one opening is made. If such an abscess is thoroughly drained, so that there is no accumulation of putrescible fluid possible, the caseous material that clings to the wall is thrown off by the granulations, the amount of discharge is reduced to a few drachms of serum, and all the outlying parts close up, leaving only one sinus leading down to the diseased bone. The drainage-tubes must be of the largest size, with walls sufficiently rigid not to collapse under pressure; and they must reach at first at least to the bottom of each pouch.

If this is not feasible, either antiseptic dressings must be applied after Lister's plan, in the hope that putrefaction may be prevented for an indefinite length of time, and that the abscess will empty itself of its contents by slow degrees and contract into a sinus, or the interior must be washed out either continuously or at frequent intervals with some antiseptic, which, if it is retained by any accident in an outlying pouch, will not cause poisonous symptoms. Treves has employed continuous irrigation with water in one or two cases of psoas abscess with good results.

A retro-pharyngeal abscess may break of itself before attention is drawn to it. If it is diagnosed, it may be opened either through the mouth (with a guarded bistoury, and taking care that pus does not enter the larynx), or externally by incision through the skin of the neck. The choice of locality s determined by the direction the abscess takes. Sometimes a sequestrum is found.

Abscesses in the dorsal and lumbar region should be opened freely and explored with the finger to ascertain if there are any outlying pockets to be drained or fragments of carious bone to be removed. Sometimes the focus of disease can be reached directly, the softened bone scraped away, and odoform applied.

Psoas abscesses should always be opened in the lumbar region. Poupart's igament divides the cavity into two, the upper half being usually much he larger; it is impossible to drain this properly from a single opening in

Scarpa's triangle. The incision is longitudinal, by the side of the erector spinæ; all the structures are divided until the quadratus lumborum is reached; the fibres of this are incised opposite the tip of the third lumbar transverse process, and with them the anterior layer of the transversalis fascia; and then the finger is passed along the anterior surface of the muscle until the psoas is reached. The line of safety is the transverse process; a lumbar artery lies above and below. In some cases an incision of this kind can be utilised to get directly at the seat of disease.

In most instances a second (and sometimes even a third) opening is required. This must be made in the situation in which the abscess points, either above Poupart's ligament (with an incision similar to that for tying the external iliac artery), or below it in Scarpa's triangle, or on the outer side or behind. I have, on several occasions, passed a large drainage-tube (half-inch internal diameter) through the whole length of the psoas, from the lumbar region to the thigh, with very great success, the temperature remaining practically unchanged; and after a time have divided this in the middle, so that the central portion of the abscess should collapse first. Usually it results in the inferior opening closing completely, and the upper one contracting into a small sinus, which, owing to its being practically straight, scarcely retains any discharge.

Paraplegia.—As the inflammation subsides and the caseous deposit shrinks, the paraplegia not unfrequently undergoes material improvement without direct treatment of any kind; and occasionally rapid recovery of power follows the application of a Sayre's jacket. This is due, in some instances, to the weight of the upper part of the body being removed and the pressure on the soft tissues relieved; but more frequently it only means that the trunk is better supported and the centre of gravity brought over the feet again. Counter-irritation is sometimes of service. The actual cautery, for example, may be applied either in lines radiating from the central projection; or a row of points may be placed in a circle around. The iron should be of a dull red heat, and the whole thickness of the skin should not be destroyed. An anæsthetic is advisable, and if the burns are covered over at once, so that the access of air is prevented, the subsequent pain is very slight.

McEwen of Glasgow has, on several occasions, resected the spines and laminæ of the vertebræ, exposed the sheath of the cord, and excised the dense, thickened, peri-meningeal connective tissue pressing upon it, with very great success; and this example has been followed by others. There is no doubt that where there is no pyrexia, where the symptoms point to pressure upon the cord without myelitis, and where, although the inflammatory process has ceased, the paraplegia does not improve, and is not influenced by treatment, an operation of this kind is not only justifiable, but strongly to be recommended. The incision should lie in the median line, and the periosteum with the muscles on either side should be stripped back, so that when the flaps are replaced a tolerably firm casing may be formed over the canal.

Curvature of the Spine

The spine may become bent, either from primary disease of the bones and joints (caries, osteoarthritis, new growths, &c.) or from weakness of the muscles whose function it is to maintain the erect position, the vertebræ only becoming affected secondarily after the deformity has already lasted some time, owing to the unequal distribution of the weight they bear. The direction may be either antero-posterior or lateral, although the latter rarely occurs by itself. The former is known as excurvation or *kyphosis* when the projection is convex backwards, incurvation or *lordosis* when it is convex forwards; the latter as *scoliosis*.

1. *Antero-posterior Curvature*

Of this there are two well-marked varieties, distinguished from each other by the shape of the curve: the one is sharp and angular, due to some local disease of the bone; the other is uniform and gradual, caused as a rule by a general affection of the whole or part of the spine.

(*a*) *Angular.*—In by far the majority of cases this is the result of caries; but it may arise from myeloid sarcoma affecting the body of one of the vertebræ, from aneurysm, carcinoma (secondary), and in infants from rickets. The projection, as its name implies, is sharp and angular, and it is exaggerated by the presence of compensatory curves in the opposite direction above and below. These are the natural result of the attempt to retain the erect position: if the spine is bent forwards at any one spot, owing to a defect in the bone, the head and the upper part of the trunk must be thrown back in order that the centre of gravity may lie over the base line of the feet; in other words, one or more compensatory curves must be developed in the opposite direction. When this cannot take place, or is imperfect, as when the disease involves the last lumbar vertebra, the patient is compelled to stoop forwards.

The diagnosis rarely presents any difficulty. In progressive *caries*, the the rigidity of the muscles, the tenderness over the spinous processes, and the care with which the patient avoids moving, especially in any way that might jar the back, are nearly always conclusive. These signs are lost to a certain extent, it is true, after the inflammatory stage is past and repair is complete; but the diagnosis is assured then by the fact that, with the exception of rickets, the other diseases that lead to the formation of angular curvature have little or no tendency to get well.

Myeloid sarcoma, except for the rapidity with which the curvature is formed, cannot be diagnosed from caries. The age is the same, and the symptoms are the same, especially as it is always attended by a certain amount of inflammation. Fortunately it is much more rare.

Rickets in infancy may be a source of considerable difficulty for a time, as the presence of this disease does not exclude caries as well. The spine of a rickety child retains for a long time the normal infantile curve, and if it is allowed to sit up the weight of the upper part of the body, acting on the softened bone, may cause a very sharp bend to take place at the junction of the dorsal and lumbar region, where caries is most common. In most cases the diagnosis may be made by laying the child upon its stomach across the nurse's knees; a rickety curve can usually be straightened out by a little manipulation as soon as the weight is taken off, while in caries this is of course impossible, as the muscles retain their rigidity: but very often in the really severe cases of rickets this fails completely, as the bones are as tender and the muscles as rigid as in actual inflammation. Fortunately in such cases, rest, cod-liver oil and good food effect a complete transformation within a week.

(*b*) *Gradual*—This may be caused either as a compensation for other defects, or by some affection of the back itself.

Compensatory curves have been already mentioned in connection with caries, but they are the natural result of many other deformities. Congenital dislocation of the hip, for example, and anchylosis of the hip-joint in a flexed position, are of necessity attended by lordosis; and where this is at all extensive there must be a compensating degree of kyphosis above. The same thing occurs in abdominal tumours and even to a slight degree in pregnancy.

Weakness of the muscles of the back, such as commonly occurs in rickety children, or in those who have outgrown their strength, is a very frequent cause of kyphosis. Sometimes the body retains its symmetry and the spine remains in the middle line; more frequently it yields to one side or the other, and lateral curvature results as well. Infantile paralysis and progressive muscular atrophy occasionally lead to the same result. At first the bodies of the vertebræ are unaffected, but after a time they become wasted and thinned in front; the thorax is crushed together and the deformity is permanent. If rickets is present the change is much more rapid, owing to the softness of the bones.

In old age the normal curves of the spines are often lost and replaced by a single general one, especially marked at the junction of the neck and thorax; and a similar deformity is produced when the spinal column is affected by osteoarthritis or ostitis deformans.

2. *Lateral Curvature—Scoliosis*

Lateral curvature may result either from want of symmetry in other parts of the body, the spine bending to one side to compensate for some other defect, and enable the head and centre of gravity of the trunk to be kept vertically over the base line of the feet, or simply from weakness, the muscles which ought to keep it straight not being equal to the work; in this case it is nearly always associated with antero-posterior curvature as well.

(*a*) *Asymmetry.*—Owing to its position in the central axis of the body, the spine is necessarily influenced by the least alteration in symmetry. Whether it is the legs, or the arms, the thorax, or even the head, if one side predominates unduly over the other the effect is visible on the spine.

Inequality in the length of the lower limbs, for example, whether it arises from congenital defect (and the legs are unequal in length in many people, without its being suspected), fracture, disease of the hip, or any other reason, must cause curvature of the spine. The base line of the pelvis is oblique; the last lumbar vertebra must be perpendicular to it; and, consequently, if the person is to stand erect, the spine above must be bent back to the opposite side.

Inequality in the strength or the development of the upper limbs produces a similar though less marked result. The most striking examples are seen in congenital absence of one of the arms; but in people who are very distinctly right-handed, the dorsal spine is always slightly convex to the right, and sometimes very decidedly so.

Asymmetry of the thorax is equally potent. In empyema, when the walls of one side have collapsed to the utmost, this is visible at once, the spine being concave to the diseased side; but even after an attack of pleurisy the same effect may be noted for some considerable time after recovery.

Even wry-neck produces the same result, although, of course, to a very much less extent. In neglected cases, in which the head is bent down for years, the side of the face, the chest, and in women even the mammary gland, fail to grow in proportion, and the spine becomes asymmetrical.

Finally, though much more rarely, lateral curvature may arise from some defect in the spine itself, caries, for example, affecting the body of a vertebra on one side; or one-half only of a vertebra being developed without the other. Paralysis of the intercostal or other muscles acting from the spine upon the trunk might cause the same result.

Occasionally, the deformity produced in this way is very considerable; but, as it is always secondary, developed to compensate for another, it naturally does not admit of rectification.

(*b*) *Muscular weakness.*—This is the most common cause of the 'growing out of the shoulder' (generally the right one), which is the symptom first noticed and first complained of in the majority of cases of lateral curvature. The muscles, which ought to keep the spine erect, are unable to do so, and it bends over to one side, and, generally speaking, forwards as well. It may be a young, rapidly growing girl, whose strength, especially at puberty, is unable to support the weight of the upper part of the trunk; or a person of better physique who has to carry constantly upon one arm or shoulder a load that is too heavy; it may be the outcome of some exhausting illness, or even of a strain injuring some of the muscles: the cause is the same in all, the weight is out of proportion to the strength.

The direction of the curve is determined by some slight degree of asymmetry, natural or acquired. In right-handed people in whom there is a dorsal convexity this is the guiding cause. The posture known as standing at ease is another: the weight of the body is allowed to rest on one leg, the other side of the pelvis droops, the base line becomes oblique, and with it the axis of the lumbar spine. To compensate for this the thorax is thrown over to the opposite side. In other cases the primary curve can be traced to a cramped position in writing, or to other causes.

This variety of lateral curvature is entirely different from the former; it is a primary affection, not developed to compensate for anything else; and, unless steps are taken to prevent it, it has a very great tendency to become worse. In many cases, it is true, it is arrested spontaneously; the period of growth and of physical weakness comes to an end, and the muscles develop sufficiently to prevent the curve becoming more distinct; but it rarely happens, unless the treatment is thoroughly carried out, that this stage is reached without leaving some degree of deformity. As patients become stronger, the curve ceases to increase, but they do not grow out of it, in spite of the popular opinion to that effect.

Curves in the spine are naturally unable, in the majority of cases, to remain single. Where the lumbar region is convex to the left, the thoracic must be equally convex to the right, and sometimes the cervical must be bent back again in order to keep the head and the centre of gravity over the base line of the feet. One of these curves is usually considered the primary, the others compensatory; but they must, with few exceptions, develop together.

Rotation.—Except in some cases of thoracic asymmetry, lateral curvature of the spine never occurs alone. It is always and necessarily associated with another deformity (rotation of the vertebræ on a vertical axis), which is even more hard to correct, and which causes much greater distortion of the trunk. The direction of this rotation is absolutely constant; the bodies of the vertebræ are always twisted farther away from the middle line, and the spines brought nearer to it. The effect, if the deformity is estimated by the spinous processes alone, is very deceptive; sometimes they are rotated so far back that they are almost brought to the median groove again, vertically under each other, as if the spine was practically straight, while in reality the bodies are carried farther and farther away until they may face to left and right, instead of forwards. The rotation apparently corrects the deformity; in reality it makes it infinitely worse.

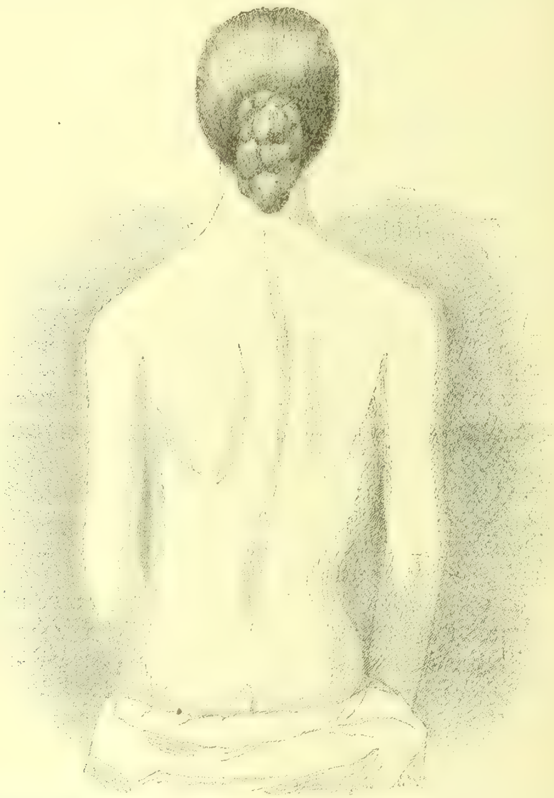


FIG. 293.—The ordinary form of lateral curvature, lumbar to the left, dorsal to the right, with growing out of the right shoulder and a depression beneath the ribs.

The cause of this rotation has been the subject of much discussion. Where there is general muscular debility, it can hardly be due to muscular spasm. As a matter of fact it is purely mechanical, the result of the fashion in which the vertebræ are articulated together. As soon as the least lateral curve makes its appearance, the weight of the upper half of the trunk presses obliquely on the lower part of the spine; and, like all oblique forces, it may be resolved into two, one acting vertically, the other horizontally. Of these almost wholly upon the bodies which are not supported by anything laterally; upon the spines which have little or nothing to do with bearing the weight of the trunk, and which are protected on either side by the articular processes, it has little or no effect; and, consequently, the former are deflected so much more forcibly than the latter that the vertebræ swing round upon an axis running down the central canal, the bodies going one way, more out of the perpendicular, the spines the other.

Effect.—In the slighter cases, in which the muscular system soon regains its strength, no gross changes are produced. In the more severe ones, and in those dependent upon asymmetry, the whole of the trunk is affected more or less. The vertebræ on the concave side are wasted from the pressure, so that the bodies become wedge-shaped; the ligaments and muscles are shortened; and the fibro-cartilage is shallower on one side than the other. Sometimes in very severe cases buttresses of bone are thrown out from one vertebra to another, as in rickets, for the purpose of support. On the convex side the ribs diverge, so that the shoulder is raised, on the opposite one they converge, so that it is equally depressed; and the structures that follow the course of the spine, such for example as the aorta, become strangely twisted into an S shape.

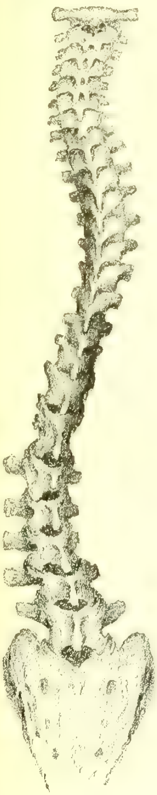


FIG. 294.—Lateral curvature with slight rotation, bringing the spines back to the middle line, and making the real deformity worse.

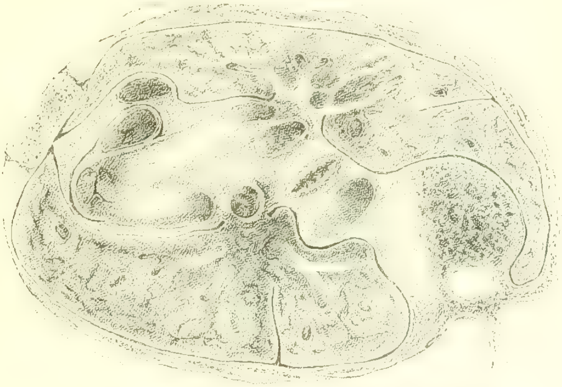


FIG. 295.—Extreme distortion of thorax consequent upon lateral curvature of the spine. The section passed through the articulation of the second costal cartilage with the sternum on the left and the seventh dorsal vertebra on the right. The vertebra, being just at the junction of the two curvatures, shows very little rotation.

The rotation complicates this still more: the vertebræ are twisted as well. In bad cases the bodies may look half to the left and half to the right, instead of all straight forwards; and in the lumbar region the transverse processes on the convex side may project so directly backwards as to be mistaken for the spines. This is not without its effect upon the vertebræ: their symmetry is entirely lost; the spine and the transverse process on the convex side are twisted toward each other; those on the concave side apart. The thorax shows the deformity even more conspicuously. The ribs on the convex side diverge and project backwards, carrying the scapula with them; then they bend back upon themselves so sharply that the true antero-posterior diameter opposite the nipple is only a few inches. On the concave side they ran forwards in the opposite direction, with scarcely any angle at all, so that the sternum is carried far away from the middle line towards the concavity, and the breast on that side is thrust as prominently forwards as the other one is depressed. In extreme cases the ribs on the concave side are crushed together, while those on the other grow outwards and backwards farther and farther until their angles produce a lateral hump which at first sight is not unlike that due to caries (fig. 296.)

The effect of this upon the thoracic and abdominal viscera is most serious. The chest is crushed down from above, twisted round, and fixed in such a way that, even when synostosis does not occur between the ribs, expansion is out of the question, and respiration must be purely diaphragmatic. The lungs are displaced, altered in shape, and unable to move in the pleural cavity; the heart is thrust to one side; the aorta is doubled almost upon itself; and the liver and kidneys are forced altogether out of position; in short, there is not one of the viscera that does not suffer more or less severely.

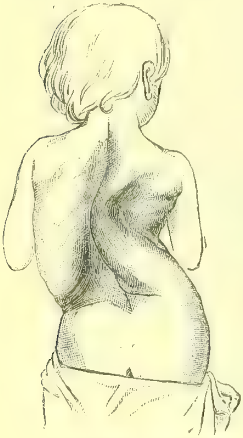


FIG. 296.—Extreme scoliosis.

In children, especially when there is a tendency to rickets, the vertebræ very soon become altered in shape; and then the deformity is practically permanent, although some improvement may be effected if the treatment is commenced before the period of sclerosis and condensation sets in. When the disease does not commence until puberty, the bones do not suffer so soon, and if only reasonable care is taken and proper treatment carried out until full growth is reached, deformity can be altogether prevented. It is very rare for lateral curvature to commence after one and twenty, although, if there is any already existing deformity, it is not uncommon for it to become worse.

Knock-knee and flat-foot occur under the same conditions as lateral curvature of the spine, and are very commonly associated with it.

Symptoms and diagnosis.—The lateral curvature in asymmetry gives rise to no inconvenience (unless, as sometimes happens in fractures, the inequality is produced suddenly and late in life); and if the muscles are well developed it has no tendency to become worse. It is the result of compensation and does not admit of correction.

When due to physical weakness its first commencement very rarely receives any attention; the nature of the complaint is not suspected until the alteration in the figure (generally the growing out of the right shoulder) is distinct. The patient may have been in the habit of standing on one leg for some time past; or of stooping with the head poking forwards, the shoulders rounded, and the abdomen projecting; but as a rule this is the first thing to cause a suspicion that there is anything more serious than simple laziness.

It is practically confined to childhood and youth, and is much more common in girls than boys. To some extent this is due to the very great strain upon the strength at puberty, especially as this is often accompanied by a period of rapid growth; but there is no question that it is largely the result of different habits and modes of life, and especially of insufficient and improper exercise, not enough attention being paid to the development of the muscular system.

Pain is unusual, although when the disease is advanced it may be very severe, possibly from pressure upon the intercostal nerves. Very often there is a weary sense of aching in the lumbar region, especially of an evening and after exertion; and with this there may be some cutaneous tenderness over the bony prominences, such as is not unfrequent in convalescents. In most cases, however, this is either neglected as natural in connection with the time of life, or is stigmatised as growing pain; and as practically there are no other symptoms, the patient is regarded as simply having outgrown her strength, until, suddenly, the want of symmetry is observed.

Method of examination.—The clothing is arranged so that the body above the iliac crests and the glutæal cleft can be inspected from all sides. If, from the height of the crests, there is any reason to suspect inequality of the lower limbs, this must be investigated first, and compensation made by placing a book under the shorter leg.

At first the patient stands upright with the feet together, in a natural unconstrained position. If the muscles are rigid and contracted, so that the attitude is stiff, they nearly always give way in a minute or two. In the meantime the tip of each spinous process is marked with an aniline pencil. In an ordinary case, with the dorsal convexity on the right, the scapula on that side is higher and more prominent, the chest fuller, and the iliac crest better marked, with a deep depression between it and the ribs (fig. 293). On the left the outline of the body is nearly straight. Seen from the side, the head pokes forwards, the thorax is flat, half-concealed by the shoulders, and the lower part of the abdomen projects, owing to the antero-posterior bend which, when the muscles are weak, nearly always complicates the lateral one. In front, the left breast stands out more than the other, and the asymmetry of the thorax is even more distinct.

Next the patient is directed to stoop forwards, the knees being kept straight, the head bent down, and the arms hanging loosely in front. This gives an idea of the amount of rotation. The ribs posteriorly are uncovered; and the projection backwards of the lower part of the chest on one side, and of the erector spinæ in the lumbar region on the other, is brought prominently into view. It is often of service to keep a record of this position by moulding a malleable piece of lead (as suggested by Roth) transversely to the ribs, between the angles of the scapulæ, and taking a tracing from this on to paper. If the deformity is conspicuous a second may be taken opposite the third lumbar spine.

Afterwards the patient is directed to straighten her back by her own unaided efforts; and if, as is probable, this merely results in increasing the deformity, an attempt must be made by manipulating the trunk and the limbs to see how far it is possible for the muscles to restore the symmetry. In cases in which there is no osseous deformity this can usually be done by placing the patient in what Roth has called the key-note position, with the right arm directed upwards and the left one at right angles to the trunk.

The prognosis depends chiefly upon the state of the vertebræ. If they are not yet affected, the patient can generally be cured, if she will take sufficient trouble, although relapses are almost sure to occur from time to time until the development of the trunk is complete. If, on the other hand, osseous deformity is already present, neither rotation nor curvature can be corrected, except in very early cases, and where there is evidence of recent rickets; all that can be done is to prevent them becoming worse.

Treatment.—The essential point is to strengthen the muscles by regular and systematic exercises without fatiguing them.

Good food, fresh air, iron, cod-liver oil, and tonics, are essential, as patients who suffer from lateral curvature are nearly always anæmic and often chlorotic. The clothing should be arranged so as to avoid compression of the lower part of the thorax; if stays are worn they should be short and there should be a vertical slip of elastic on each side, to admit of easy expansion, and great care must be taken to avoid injurious habits, which, if they have not caused the deformity, have at least made it worse, such as long standing, especially standing at ease; sitting obliquely in a cramped position when writing, without a proper back-rest, or with the legs crossed; and stooping. The back should be well sponged and rubbed every morning; and massage, stroking and kneading the muscles on either side of the spine, and galvanism, should be applied to relieve the aching and sense of fatigue which are nearly always present at first after any little exertion.

Where the muscular strength is good, and the curvature only slight, general exercises may be prescribed, especially swimming, balancing a light weight upon the head, swinging by the hands, and the use of a light pair of dumb-bells. Many of the exercises on the horizontal bar may be performed as the general nutrition improves; but, whatever is done, the patient should always stop short at the least sensation of fatigue, and should rest upon a properly shaped chair, with the seat horizontal, a foot-rest, a cushion arranged to fit the loins, and an excavation above for the shoulders. A similar chair, with the back adjusted so that the angle can be altered, should be used for all purposes—meals, playing the piano, writing, &c. At night, Barwell's sling (fig. 297) is sometimes of service.

In more severe cases, in which the strength is unequal to this, much milder exercises, limited to special groups of muscles, must be prescribed: the intrinsic muscles of the thorax (deep inspiration and expiration); those of the head and neck; those of the upper extremity, that act upon the trunk; then those of the lower (circumduction of the shoulder and hip); the erector spinæ; the abdominal group, &c., being worked quietly and slowly, one after the other, a certain number of times (depending upon the strength of the patient), first, so far as possible, in the recumbent position, then erect. The same precautions as to fatigue must be adopted here; and after each practice the muscles of the back should be well rubbed and sponged.

As Roth has pointed out, it is essential first of all to correct the antero-posterior curvature. Afterwards, when the muscles have regained their power over this, exercises may be practised in the key-note position, or in that which tends most to bring the spine to its natural shape. Later ones may be more severe, as, for example, when the patient, lying prone upon a table with the pelvis and legs supported, and the latter fixed (by some one sitting on them), raises the trunk from below to the horizontal position and slowly lowers it again.

During this treatment Roth recommends that the patient should stand frequently in front of a looking-glass with the eyes closed, and straighten herself up until she believes that she is standing erect; generally she finds, on opening her eyes, that the head is on one side, and one shoulder unduly raised. By degrees the muscular sense, which requires re-educating, becomes so much improved that she is enabled to place herself in a better position voluntarily, and at once.

Mechanical supports should never be used for lateral curvature of the spine when it is possible to avoid them, and then only in the day time, not when the patient is lying down. Where there is paralysis of the muscles of the back, or where, as I have seen on one or two occasions, lateral curvature has developed rapidly after a severe strain (some of the muscles probably being ruptured or so stretched that, for the time at least, they were paralysed), they are undoubtedly beneficial as adjuncts, only they

FIG. 297.—Barwell's sling for correcting the rotation in the recumbent position.

nust be gradually left off as the muscles regain their power. To keep them n only causes atrophy. In advanced cases, in which the deformity is so reat as to resemble angular curvature in appearance, and the muscles are opelessly wasted, their use cannot be avoided; the deformity is permanent, nd it is only possible to prevent its becoming worse by supporting the runk. Many of these cases suffer very severe pain, probably from pressure pon the intercostal nerves, and only experience relief when wearing some ind of mechanical support.

INFLAMMATION OF THE SPINAL CORD AND MENINGES

Acute Traumatic Meningitis

This is not uncommon after wounds that involve the membranes, or after unshot injuries of the vertebræ; the former are nearly always punctured, the tter are invariably bruised, so that there is everything to favour septic inflamation: and under these conditions it may commence in the membranes themlves. Much more rarely it is met with after injuries that are not compound, ch as sprains, wrenches, and simple fractures, and then it is generally due the extension from surrounding structures. Periostitis or arthritis breaks it and runs on to suppuration; or an abscess forms in the crushed and uised tissue around the theca and between the bones; or the inflammation starts outside the spinal column altogether, and spreads into it along the nerves or lymphatics, or more directly through a rupture in some of the posterior ligaments.

The pathological appearances naturally differ to a certain extent; sometimes the effusion seems to be limited, but more frequently the pus spreads down the whole length of the theca and involves the subdural as well as the subarachnoid space. In extreme cases the cord is injected and softened so as to be almost diffluent; and the pia mater is thickened and infiltrated with lymph which spreads along the veins like white streaks on either side.

It may begin within a day or two after the accident, or when it is due to gradual extension it may not make its appearance for a long time. As a rule there is a rigor or shivering; the temperature rises at once, and may become exceedingly high in the first few hours; the pulse becomes full and rapid; the respiration is shallow and hurried; vomiting is not infrequent; and delirium and other signs of the most intense fever follow very soon. Reflex action is at first exaggerated; very soon it begins to fail; voluntary power is impaired almost from the first. There is the most intense pain down the back, often spreading round the trunk as the roots of the spinal nerves become involved; hyperæsthesia is almost always present, and sometimes it is general, so that the weight of the bed-clothes on any part of the body causes agony; the muscles of the back are kept perfectly rigid; often there is opisthotonos, the back of the head boring into the pillows; and sometimes there are violent spasmodic contractions of the muscles of the limbs and even general epileptiform convulsions. As a rule respiration soon begins to fail, owing to the cervical portion of the cord becoming involved, and severe cases may terminate fatally in this way within forty-eight hours. If the patient survives longer, very rapid muscular wasting, sloughing bedsores, cystitis and nephritis are not uncommon.

Myelitis

Red softening is present above the seat of injury in all cases of severe bruising of the cord, whether compound or not; and especially in the cervical and upper dorsal regions frequently proves the immediate cause of death by extending to the respiratory centres. The vessels in the cord and in the pia mater dilate; the hyperæmia becomes intense, and in severe cases numerous small ecchymoses make their appearance; the nerve-cells break down; the medulla pours out and forms the so-called myelin drops; and the neuroglia melts away as the exudation pours out through the walls of the vessels. In some cases this is so marked that actual suppuration occurs, small collections of pus being found here and there, especially in the grey substance, and the cord itself above the seat of injury is almost destroyed.

The symptoms are rarely so intense as in acute suppurative meningitis; there may be a rigor at the commencement, but the fever is not so high, nor is the pain so severe. On the other hand, the functions of the cord are lost much sooner; there may be transient hyperæsthesia, or the sensation of a band round the body, but it lasts a very short time; voluntary power fails almost from the first; muscular spasms rarely occur, and reflex action, though it may be slightly exaggerated just at the beginning, is soon destroyed. Rapidly ascending paraplegia is the most marked symptom.

Acute bed-sores, sloughing cystitis, and other forms of intense inflammation running into gangrene are especially common in cases of myelitis, and probably are in a certain measure caused by it.

Chronic Meningomyelitis

Injuries of the spinal column are occasionally followed by a peculiarly insidious form of inflammation which affects both cord and membranes. It may occur after any accident, no matter how trivial, but it seems especially prone to follow sprains and contusions in which it may be supposed the ligaments have been torn or blood extravasated into the canal. There is no doubt it does occur after railway collisions, perhaps more frequently after them than after any other form of accident, though, as already mentioned, many, if not most, of the cases of so-called railway spine are better explained, in part by the injury to the bones and ligaments, in part by the nervous shock.

The symptoms, especially at the beginning, are very ill-defined: generally it is impossible to fix the date of their first appearance; it may be a few days, it may be a few months after the accident, and they are hardly ever the same; some depend upon the degeneration of the cord, others upon the thickening of the membranes. In most cases the former are the more definite; there is no fever, the movements of the back are not interfered with, and there is no pain on pressure, for as long as the bones and ligaments are intact none can be transmitted to the interior of the canal. But there is very soon evidence that certain portions of the nervous system are beginning to lose their power; rapid wasting perhaps and loss of strength are noticed in a particular group of muscles, and it is found that their electric reaction is no longer normal; sometimes this remains stationary for a period, sometimes it extends until a whole limb is paralysed. In other cases micturition becomes difficult, or defæcation involuntary; sexual power may disappear, or, if the cervical portion of the cord is involved, there may be persistent vomiting or hiccough, or vision may be impaired from interference with the accommodation. Then the sensibility of the skin becomes blunted, a slight degree of hyperæsthesia may be present for a time, but this soon gives way, and the cutaneous reflexes fail. One portion of the cord after another becomes involved, the loss of power becomes more and more general, and gradually, as the degeneration extends, the muscles of respiration become affected, and death ensues from ascending paraplegia, or the patient becomes so weak and feeble that some slight accidental disorder soon proves fatal.

If, in addition to this, the membranes are thickened or adherent to the cord, there are other symptoms as well. The roots of the spinal nerves are affected; there is pain on moving or twisting the back; the spine is held stiffly, and sometimes there is a certain amount of muscular spasm, just as when the ligaments are strained. Frequently there is a sense of constriction, as if a girdle were tied round the body, or there is intense pain at the periphery or along the course of certain nerves; formication, tingling, and numbness are not uncommon, and in a few instances vasomotor changes, alterations in the temperature of certain parts, and even cutaneous eruptions have been noticed. In the worst cases other parts of the nervous system become affected as well; the movements of the tongue, for example, are interfered with and deglutition and articulation impaired.

Treatment.—The treatment of these inflammatory complications is very unsatisfactory. In the case of a wound means must be taken to secure primary union, or, if this is out of the question, to prevent septic absorption by efficient drainage. Where the skin is uninjured, all that can be done is to rectify any deformity that is present, and by means of perfect rest maintained for a sufficient length of time keep the consecutive hyperæmia within due bounds. Leeches and cupping may be tried where the hyperæsthesia is very marked, or if there is much muscular spasm, but care must be taken that the punctures do not become the starting-points of sores. Ice may be used in the same way, but the application must be continuous. Ergot, belladonna, and aconite have been strongly recommended, and small frequently repeated doses of calomel have been given for the same reason as in cerebral inflammation, but it very rarely happens that any distinct benefit can be traced to their use.

In chronic cases, most reliance must be placed upon iodide of potash and mercury (especially the bichloride) in small doses, kept up for a long period. Even when there is no suspicion of syphilis, their use has been followed by very considerable benefit. Counter-irritation, flying blisters, dry cupping, stimulating liniments, and even the actual cautery are sometimes of assistance as well. So long as there are any symptoms of progressive inflammation, galvanism, strychnia and tonics should be avoided; afterwards, when this has subsided, they may prove of service in restoring the nutrition.

TUMOURS OF THE SPINAL CORD

In one case (Horsley and Gowers) a tumour (myxoma) was successfully diagnosed and removed from the spinal cord. It had caused complete paralysis of the lower limbs and bladder, and anæsthesia up to the ensiform cartilage, with severe girdle pain in the region of the sixth and seventh intercostal nerves, especially on the left side. At the time of the operation sensibility was absent as high as and including the fifth dorsal nerve on the left side and impaired on the level of the fourth.

A longitudinal incision was made down the centre of the back; the muscles separated from the laminæ and the back of the transverse processes by the free use of the knife; the vertebral aponeurosis divided transversely; the spines of the fourth, fifth, and sixth vertebræ removed; and then the laminæ and ligamenta subflava. The dura mater was then slit up, and as nothing was seen the spine of the third was taken away too. A small almond-shaped growth was then found lying upon the posterior root zone of the left side, involving the root of the fourth nerve four inches above the level of the anæsthesia. The tumour, with the nerve, was dissected off the cord; the margins of the dura mater approximated; the skin and the muscles sutured and a deep drain inserted. The patient made a perfect recovery in every way.

The dura matral sheath of the cord has been exposed on several occasions in removing congenital lipomata, false spina bifida, and congenital sacrococcygeal tumours, and has been recognised by its pulsation.

TREPHINING THE SPINE

This operation has been performed for injury, compression of the cord consequent upon caries, for the removal of tumours and for persistent neuralgia. With regard to the first of these, there are, according to Thorburn, sixty-one cases on record, of which one, due to direct violence, was a complete success. Of the remainder there are only seven in which the locality of the injury is known and in which there was a *boná fide* improvement, and all these were in the lower dorsal or lumbar region. Further, in six of these the improvement does not appear to have been traceable to the cord, but to the cauda equina; and in one only of the whole sixty is there anything like satisfactory evidence of recovery of any part of the spinal cord itself.

According to the same authority trephining the spine has been performed thirteen times (on twelve patients) for compression of the cord consequent upon caries; and in seven of these there was marked relief, directly resulting from the operation. In one case the phrenic nerve was wounded, causing death; and in another the operation is stated to have hastened the end; the rest were not benefited or injured by it. Horsley's is the only case in which the vertebral canal has been opened and the dura matral sheath slit up for the removal of a tumour that did not project externally. Abbe of New York has divided both roots of the sixth and seventh cervical nerves outside the dura, and the posterior roots of the seventh and eighth inside, for intractable brachial neuralgia; but whether with permanent benefit is not yet known.

No special directions can be laid down. The incision should be in the middle line, the patient being supported in the three-quarter prone position. The periosteum, with the muscles covering it, should be detached as far as may be required from the spines and laminæ on either side, partly to avoid hæmorrhage, which is free and difficult to control, partly in order that if the bone is removed a firm protection may be left, and the surface of the laminæ deeply grooved with a saw. The section is completed with bone-forceps. The subsequent steps depend upon the nature of the lesion: granulation-tissue has been scraped away until the surface of the dura mater, apparently unaffected, was exposed; dense leathery masses of thickened inflammatory deposit have been dissected off the theca; and considerable portions of the theca itself that were hopelessly involved have been excised as well. In several instances in which this operation has been performed for pachymeningitis, the pulsation of the cord has been seen to commence as soon as the thickened tissue was removed; sensation and warmth have reappeared in the lower limbs within twelve hours, and voluntary movement within a few days.

CHAPTER IX

INJURIES AND DISEASES OF THE EYE

By J. Hutchinson, jun., F.R.C.S.

1. The Methods of examining the Eye. Errors of Refraction

For ophthalmic work, the student should be provided with the following:—a refraction ophthalmoscope (of which there are many varieties, the one designed by Mr. Stanford Morton being perhaps the best), and a large convex glass lens having a diameter of two inches and a focal length of about three inches. In addition to these, for estimating refraction, a 'keratoscopy-mirror' is useful, and a pupillometer should be added to the ophthalmoscope case.

By 'oblique illumination' of the eye is meant the projection of light from a lamp at the side of and somewhat in front of the patient's head through the convex lens into the eye, the lens being held at about its focal distance from the latter. Oblique illumination is especially valuable for detecting opacities or 'nebulæ' in the cornea, foreign bodies on the latter, or commencing cataract.

By 'indirect ophthalmoscopic examination' is understood the following: The patient is seated in a dark room with a light behind and to one side of his head, the observer uses the plane mirror of the ophthalmoscope at a distance of about eighteen inches, and reflects the light into the pupil of the patient's eye, then interposing the convex lens held in the left hand at rather less than its focal distance from the latter. The patient is directed to look at the observer's right ear if the right eye is being examined, at the left ear if the left eye is under observation. By this means an inverted image is obtained of the optic disc, and the whole fundus can be explored by making the patient look upwards, downwards, and to either side. It must be remembered that the image obtained is an inverted one, and hence, for instance, a hæmorrhage seen apparently above the disc is really situated below it.

In the 'direct method' of examination, on the contrary, the image obtained is not inverted. The oblique mirror of the ophthalmoscope is used, the light being as near as convenient to the patient's ear. The surgeon, using his right eye when examining the patient's right one and *vice versâ*, approaches his eye and instrument until the latter is just in front of the cornea, whilst reflecting the light steadily into the pupil. If the patient looks straight forward, the optic disc will be seen, if straight at the observer, the region of the macula or yellow spot can be explored, &c. Since reflecting the rays on to the latter region produces reflex contraction of the pupil, it is a great convenience if the contractor pupillæ be paralysed by homatropine. In estimating refraction, too, the previous use of this drug is often necessary, especially in young subjects and in those with hypermetropia or 'long sight.' An aqueous solution of homatropine hydrobromate (four grains to the ounce) is employed, two or three drops being applied within the conjunctival sac every ten minutes. After this has been repeated three or four times, practically complete paralysis of the ciliary muscle and contractor pupillæ is obtained, both muscles recovering within twenty-four hours. For ophthalmoscopic use, homatropine has largely displaced atropine, since the paralytic effects of the latter often persist for nearly a week. Further, if atropine be used in patients of advanced age, there is a certain risk of causing glaucoma.

The student should practise the use of both direct and indirect ophthalmoscopic examination, since both are indispensable. We may now briefly notice the methods of detecting and estimating errors of refraction by the ophthalmoscope.

In *hypermetropia*, otherwise known as long sight, the eye is shorter than usual, and if the ciliary muscle be at rest, parallel rays are brought to a focus behind the retina. Rays proceeding from an object at a distance of twenty feet or six mètres may be regarded as parallel ones. Hence a hypermetropic eye, if the ciliary muscle be for the time not in action, has a certain amount of defect in distant vision, a defect which the patient can overcome by contracting his ciliary muscle, rendering the lens more convex, and thus bringing the rays to a focus on the retina. Rays proceeding from a near object, *e.g.* the type of a book, can also be brought to a focus on the retina with extra use of the ciliary muscle, and it is in near vision that the hypermetrope nearly always notices his defect, the strain upon the accommodation ausing aching in the eyes or head.

Hypermetropia may be detected by the surgeon by the following means :—

1. In using the indirect method, if the image of the disc be obtained and hen the surgeon gradually withdraw his mirror and lens whilst keeping the isc in view, the size of the image will be noticed to decrease.

2. If the direct method be employed, as the observer approaches the atient whilst reflecting the light into his eye, an image of the retinal vessels will be obtained at a distance of some inches from the eye. This image will ppear to move (from side to side or vertically) in the same direction as the bserver's eye. The distance at which the vessels can be distinguished aries with the degree of hypermetropia.

3. The observer uses the keratoscopy mirror (or the plane one in his phthalmoscope) at a distance of at least one mètre, and reflects the light om the lamp placed above and behind the patient's head into his cornea, aking a shadow pass across the latter by inclining the mirror. If the hadow passes across the cornea in the direction opposite to the one followed y the mirror, the eye examined is either hypermetropic or emmetropic (of ormal refraction). The test being repeated with a lens[1] of + 1 D (40″)

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[1] The unit of the Dioptric System, which is now universally employed, is a lens of out 40 English inches focal length, +2 D signifies a convex lens of $\frac{40}{2} = 20''$ focal ngth, −5D a concave lens of $\frac{40}{5} = 8''$ focal distance, &c. To convert the French into the nglish system, divide the number of dioptres into 40. The standard of normal acuteness vision is represented by $\frac{6}{6}$, *i.e.*, letters which subtend an angle of 5° at the distance of 6 ètres (about 20 feet) are used and can be read at this distance. $V = \frac{6}{12}$ implies that e patient can only read at 6 mètres type which subtends this angle and should be read 12 mètres distance, &c.

focal length immediately in front of the patient's eye, if the latter be emmetropic there will be no moving shadow. If hypermetropic, lenses of increasing strength are used until the shadow-movement ceases, when the deduction of about 1 D from the lens required to effect this will give the amount of hypermetropia.

4. By using the direct method the details of the disc can be clearly seen in a hypermetropic eye when + glasses are used in the ophthalmoscope. The highest lens with which the smaller vessels can be distinctly seen represents the total amount of hypermetropia. The observer's eye in this test must be brought close to the patient's.

It must be remembered that these methods of estimating the amount of hypermetropia are only available if the patient be relaxing his accommodation, and most easily if the ciliary muscle be temporarily paralysed by homatropine or atropine.

In *myopia* or short-sight precisely the same tests are employed: in (1) the size of the image increases as the lens and ophthalmoscope are withdrawn; in (2) the image moves in the opposite direction to the observer's head; in (3) the shadow moves across in the cornea in the same direction as the mirror is tilted; and in (4) the details of the disc cannot be clearly defined unless a − lens equal to the amount of the patient's myopia is used in the ophthalmoscope.

A myopic eye is one in which the length of the globe is greater than normal, and therefore parallel rays passing through the cornea are brought to a focus in front of the retina. Hypermetropia is a congenital condition, does not tend to increase as age advances, but, on the other hand, occasionally becomes less. Myopia usually comes on when the eyes begin to be used much for near vision—*i.e.* at school or during early adult life—and tends to increase with more or less rapidity. Overwork of the eyes (especially in a bad light), the habit of stooping and bringing the book, &c., very near to the eyes, and reading small or bad print, favour the progress of myopia. Twelve inches is about the best distance for near vision, and if the amount of myopia be so great as to compel the patient to hold his books, &c., nearer than this, concave glasses should be given of a sufficient strength to enable him to read comfortably at about this distance. For good distant vision a myopic patient may be ordered the full correcting glasses, and if these do not exceed −4D or −5D, they may be used for both near and distant vision.

A hypermetropic patient has no difficulty in distant vision as a rule, but the extra strain thrown upon his ciliary muscle in near work tends to produce pain in the eyes and headache (especially frontal), and these symptoms may be entirely relieved by ordering the full correction to be worn for near vision.

Complications of hypermetropia and myopia.—The chief complication of hypermetropia is convergent strabismus, the form of squint most often met with in practice. In this, whilst one eye is directed upon a near object, the axis of the other passes to its inner side (*i.e.* between the object and the non-squinting eye). Generally the squint affects the same eye always; it is then said to be constant, and the vision of the affected eye is often defective (*e.g.* $\frac{6}{60}$). The image is mentally ignored, and hence the patient does not complain of double vision. Convergent strabismus comes on in childhood, and if the case is seen early and the squint be not of very high legree, it can be cured by the continuous use of fully correcting glasses (*i.e.* hose equal to the total amount of hypermetropia found). It must not, nowever, be expected that vision will much improve in the defective eye, hough it is well to advise the patient to practise this eye by covering the other from time to time. If the squint be alternating (that is, if first one eye squint and then the other) vision is usually good in both.

If the strabismus has existed for some years, or if it be of high degree 20°–30°), probably a tenotomy of one internal rectus muscle will be required. n most cases it is advisable to give the correcting glasses a trial for some nonths, and then to perform the tenotomy if the squint is still present, rdering the patient to continue their use after the operation.

There are several complications of myopia, especially if it tends steadily o increase. Perhaps the most frequent is the occurrence of floating specks muscæ volitantes) seen before the eye, and due in some cases to actual opacities in the vitreous, though often none can be detected.

Hæmorrhages into the vitreous or retina, detachment of the latter from he choroid, and atrophic patches in the region of the yellow spot (choroiditis posterior) are serious and not uncommon results of progressive myopia.

Owing to the strain put upon the internal recti, divergent strabismus may come on, and give rise to double vision. Besides ordering suitable glasses or a myopic patient, the surgeon should caution him against too prolonged work with the eyes, and should insist upon the light used in the evening being steady, of good quality, and so placed that the glare may not come upon the eyes themselves. Tonics also may be of use, and means should be aken to prevent stooping at the work, and books with very small or bad type should be avoided. If divergent strabismus is present, it may be treated by division of one or both external recti, or by advancement of one internal rectus.

A very constant ophthalmosopic feature of high myopia is the formation of a whitish crescent at the outer side of the disc, due to the exposure of the sclerotic by the shifting of the choroidal edge (this is known as a *posterior staphyloma*).

In both simple hypermetropia and myopia parallel rays are brought to a focus either behind or in front of the retina when the accommodation is at rest. But sometimes one meridian of the cornea or lens is more curved than another, and in such a case the rays passing through the two meridia are brought to different foci. Such a condition is termed *astigmatism*. If the wo meridia are at right angles to each other, as is usual, the astigmatism is aid to be regular, and can be corrected by suitable cylindrical lenses. If, n the other hand, one small part of the cornea is more refractive than the est (as in conical cornea or after ulceration) the astigmatism is said to be rregular, and cannot be benefited by glasses.

As a rule, in regular astigmatism the vertical meridian of the cornea is nore refractive than the horizontal: if both are myopic, the case is said to be ne of compound myopic astigmatism, &c.; if one meridian is myopic and he other hypermetropic, the term mixed astigmatism is used. Often the neridia are not vertical and horizontal, but placed obliquely, whilst still at ight angles to each other. Then the exact obliquity has to be carefully scertained, and for determining this keratoscopy is invaluable, its result eing always confirmed by trial with cylindrical glasses in distant vision.

Regular astigmatism is, as a rule, congenital. Low degrees are very common and may give little or no trouble; occasionally it is left after extraction of cataract or iridectomy, owing to traction on the cornea by the scar of the operation wound.

Apart from the errors of refraction we have briefly noticed, we have to consider weakness of sight due to muscular failure and to senile changes in the eye. The power of accommodation for near objects depends on two factors—the strength of the ciliary muscle and the elasticity of the lens; and it steadily decreases from childhood to old age. It may be represented by the highest concave lens which can be overcome by contraction of the ciliary muscle—thus, for instance, a patient with normal vision at the age of 15 can overcome a lens of -12D (*i.e.* can read $\frac{6}{6}$ still by an effort when this lens is placed before his eye). The 'near point' (the shortest distance from the eye at which it is possible to read 1J.) will be represented by 40 divided by 12 or $3\frac{1}{3}$ inches. At 45 years the accommodation is only 4·5D and the near point 9″. It is about this age that it becomes necessary to assist the accommodation with convex lenses for near vision, and the following table indicates the requisite correction for *presbyopia* or 'old sight.'

Age	Glass required for reading at about 12″, &c.	Age	Glass required for reading at about 12″, &c.
45 . . .	+1D	65 . . .	+4·5D
50 . . .	+2D	70 . . .	+5·5D
55 . . .	+3D	75 . . .	+6D
60 . . .	+4D		

The onset of presbyopia is delayed by myopia, hastened by hypermetropia; thus, a patient with myopia of -4D may not require glasses for reading until the age of 60; a patient with $+2$D of hypermetropia will need about $+3$D for reading at 45 years, &c.

In early life the ciliary muscle may be temporarily weakened from various causes—diphtheria, prolonged suckling in women, &c. Difficulty in near vision and aching of the eyes may also depend upon strain of the internal recti muscles from over-work, and in a few cases prisms are of service. As a rule these cases of 'asthenopia' are best treated by tonics, rest of the eyes, out-door exercise, and other measures to improve the general health of the patient.

SECTION I.—INJURIES

1. BURNS AND SCALDS

IN cases of simple burns of the face the eye-lashes are often temporarily destroyed, and muco-purulent conjunctivitis is not infrequently observed. The extreme sensibility of the cornea and conjunctiva render the slightest burn or scald of these parts very painful, and continuous cold applications (iced water or boracic solution) and pure cocaine used with vaseline are very useful in relieving the pain. As soon after the accident as possible it should be ascertained whether the cornea has been damaged, for the prognosis as regards vision will depend chiefly upon this point. If a whitish opacity is seen a very guarded prognosis should be given, since it rarely clears off completely and in some cases the whole cornea may slough. If the ocular or palpebral conjunctiva be much burnt, adhesion of the two (symblepharon) is very likely to take place—and during the healing process this adhesion should be limited as far as possible by the frequent insertion of boracic acid ointment or vaseline. Scalds from quicklime, sulphuric acid, caustic potash, or soda, &c., are not infrequent, and in their treatment a weak neutralising solution (acid or alkaline) should be freely syringed between the lids. Any particles of lime or mortar, &c., which may have got into the palpebral sacs should be removed by syringing, the use of forceps, &c., and in severe cases (especially in children) it is best to give an anæsthetic in order to effect this thoroughly.

Lead lotion should not be used in these cases, for fear of a lead deposit on the cornea.

2. Foreign Bodies

The removal of foreign bodies from the corneal surface is described under Diseases of the Cornea; sometimes a piece of iron is driven right through into the anterior chamber, the lens or the vitreous. In such cases its removal has been frequently accomplished by the use of the fine-pointed electro-magnet introduced through the original wound or a fresh one made with a narrow keratome. The 'cannula-forceps' is also of use if the foreign body is not of iron and can be readily seen. Traumatic cataract is certain to result if the lens-capsule is wounded by a foreign body—it should be treated by continuous cold applications and the frequent use of atropine for a few days. The lens swells up, becomes milky-white and generally protrudes into the anterior chamber. So long as the tension of the globe remains normal no other treatment is needed than that mentioned; but if it is distinctly raised and there is marked pain and congestion, it may become necessary to incise the periphery of the cornea with a narrow keratome and let out the soft opaque matter with a curette introduced into the little wound thus made. Atropine and ice should be again employed after the operation.

Although a foreign body may remain embedded for long in the vitreous, sclerotic, &c., without giving trouble, as a general rule an eye with such an injury retains but little sight, and is to a certain extent liable to set up sympathetic ophthalmia in the other one. Severe inflammation or suppuration of the injured eye may result from the introduction of septic matter with the foreign body, and in this case excision of the globe should be performed. The same rule holds good if there is reason for believing that the eye (though quiet) contains a foreign body and has permanently lost all useful visual power.

3. Wounds

Abrasions of the corneal surface produce much pain and photophobia, and in elderly people may be the starting-point of hypopyon, iritis, or serpiginous ulceration. Continuous warm boracic fomentations, the use of cocaine and (if there is any suspicion of iritis) of atropine, form the suitable treatment.

Perforating wounds of the cornea are very liable to be attended by prolapse of the iris, which follows the escape of the aqueous humour. Cocaine having been used (in certain cases general anæsthesia is better), an attempt should be made to reduce the prolapsing part with a small curette or caoutchouc spatula; but if this fails the protruding part of the iris should be gently drawn forwards with fine forceps and snipped off with scissors. Either eserine or atropine should subsequently be used for some days, so as to draw the rest of the iris away from the wound: eserine if the latter is in the periphery of the cornea, atropine if it is central or if there is fear of iritis.

Any wound of the sclero-corneal junction or involving the structures immediately in front of or behind this spot, is dangerous, owing to the risk of *sympathetic ophthalmia.* This disease consists essentially in an irido-cyclitis of the non-injured eye, coming on usually within a few weeks (but sometimes many months or even years) after the date of injury. Sometimes it takes the form of serous iritis with dotted opacities on the back of the cornea, sometimes optic neuritis develops. But the usual form consists in iritis leading to tough adhesions and secondary cataract, and tending slowly to completely destroy the sight. What is the explanation of this disease, whether some infective material is conveyed into the circulation from the injured and inflamed eye and lodges in the other one, or whether the inflammation travels along the optic or ciliary nerves, remains doubtful. The important fact to remember is that (with rare exceptions) sympathetic ophthalmia is due to a wound involving the ciliary region, especially if it inflames; and hence immunity from the disease is worth procuring at the expense of excision of the injured eye, if the latter retain little or no vision; for removal of the exciting eye *after* sympathetic ophthalmia has come on is useless.

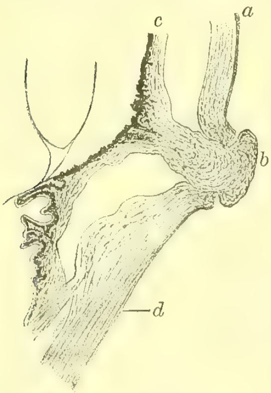

FIG. 298.—Prolapse of inflamed iris through a wound of the cornea. *a*, cornea; *b*, prolapsing part of *c*, the iris; *d*, ciliary region.

The treatment in the latter case consists mainly in using atropine, counter-irritation to the temple and protecting the eyes from light. Mercury, quinine and belladonna given in full doses have each their advocates.

Occasionally a free iridectomy, performed after the acute stage has passed off, is useful.

Sympathetic irritation is a less severe complication of wounds of the eye, though sometimes it passes on to true ophthalmia. Its symptoms are attacks of congestion and watering of the non-injured eye, failure of accommodation, irritability on exposure to light, &c. In such a case it is best to excise the injured eye.

4. CONTUSION OR CONCUSSION INJURIES

In most cases of 'black-eye' the globe itself escapes injury; the best way of obtaining absorption of the extravasation consists in using warm fomentations after the first twenty-four hours (during which cold should have been applied). The following may result from blows involving the eye itself.

1. *Traumatic mydriasis—i.e.* fixed dilatation of the pupil with more or less failure of accommodation. It is a singular fact that this mydriasis may persist for many years, or may disappear in a few days.

2. *Hæmorrhage into the anterior chamber* is of slight importance, since the blood is rapidly absorbed under belladonna fomentations. Hæmorrhage into the vitreous is much more serious, and generally affects the vision permanently. It must be suspected to have occurred after an injury, when (the lens and

ornea being clear) no reflex can be obtained from the back of the eye on phthalmoscopic examination. Sometimes the floating clots can be detected y oblique illumination.

3. *Dislocation of the lens* may be either into the anterior chamber or nore commonly) into the vitreous ; a very slight displacement is of serious nport as regards vision. It may be suspected from tremor of the iris on idden movement of the eye, and from bulging of the iris at one part and ecession at another. If the pupil be dilated the edges of the lens can usully be detected as a dark curved line if it be dislocated. Cataract and glauoma are both liable to ensue, and in some cases the displaced lens causes itis, or shrinks up or calcifies. Any treatment but excision of the eye is as rule useless.

4. *Rupture of the globe.*—This usually occurs at or towards the ciliary egion where the sclerotic is thinnest, and calls for excision in most cases. oth lens and iris have, however, been completely extruded through a rupture nd the eye has retained some vision.

5. *Detachment of part of the iris from its ciliary origin.*—This is known s 'coredialysis,' and may not be limited to one point.

6. *Rupture of choroid or retina*, generally recognisable with the ophthalnoscope as linear bands of white with pigmented borders. Its effect upon ision will depend upon whether the rupture involves the yellow-spot region r not. Detachment of the retina may also result in myopic eyes from very light contusions ; it is recognised with the ophthalmoscope as a white mass ulging into the vitreous, often furrowed on its surface and with the retinal essels running over it. If limited to one segment of the retina vision may e impaired only in the corresponding part of the field, but not infrequently ight is completely lost.

7. *A peculiar form of retino-choroiditis*, in which there is both atrophy nd pigmentation, is liable to come on within a few weeks of concussion of he globe. It may be limited to the yellow-spot region or may be generally iffused, sight being impaired to a corresponding extent. The possibility f this should be borne in mind in giving a prognosis as regards vision after blow on the eye.

8. *Concussion cataract* is described under Diseases of the Lens (see age 831).

SECTION II.—DISEASES

DISEASES OF THE CONJUNCTIVA

'HE chief of these are : (1) catarrhal or muco-purulent ophthalmia ; 2) purulent ophthalmia ; (3) granular conjunctivitis ; and (4) chronic conunctivitis without granulations.

1. CATARRHAL OPHTHALMIA

An acute form of conjunctivitis, attended with more or less discharge of ıucus or muco-pus, occurring at all ages, but especially in children and oung adults, and decidedly contagious. The cause is often doubtful : exposure to draught is sometimes assigned; the subjects have not uncommonly recently recovered from measles or scarlet fever (especially the former); while sometimes it runs through all the members of a family or dwellers in a house. It appears to be most prevalent in the spring and autumn. The first symptom is a feeling of grit under the lids, with pain and perhaps photophobia, the lids are stuck together on waking in the morning, and when the eyes are examined the whole conjunctiva is seen to be intensely congested. In strumous subjects especially, phlyctenules or phlyctenular ulcers are met with at the same time, and such cases are slower in their course than the uncomplicated ones, which, as a rule, completely recover in a week or two. Catarrhal ophthalmia can be readily distinguished from the more serious purulent form due to gonorrhœal infection by the character of the discharge, which in the former disease is rarely profuse, and consists of whitish-yellow sticky mucus; small conjunctival ecchymoses are often seen at the onset of the attack.

Treatment.—A mild astringent lotion should be used freely to bathe the conjunctival surface three or four times a day, and the edges of the lids should be anointed with some simple ointment (ung. Galeni, ung. cetacei, or a very weak ointment of the yellow oxide of mercury) at night-time. Either of the following lotions are useful:—

Acidi boracici	gr. x
Zinci sulphatis	gr. ij
Glycerini	♏ x
Aq. destill. or aq. rosarum	℥ j

Argenti nitratis	gr. j or gr. ij
Aq. dest.	℥ j

or a saturated solution of boracic acid in distilled water.

Photophobia is rarely very pronounced unless a corneal ulcer is present, but it is well to use a shade for a few days; the common practice amongst patients of tying the eyes up, or, worse still, of applying poultices, should be forbidden.

2. Purulent Ophthalmia

This form of conjunctivitis is almost always due to inoculation with gonorrhœal pus, and it is most often seen in young infants, infected during the passage of the head through the vagina. It is then called ophthalmia neonatorum, and the first symptoms—swelling of the lids with discharge becoming more and more profuse—are noticed about the third day after birth. It is a disease of great importance, since, unless prompt and thorough treatment be adopted, there is much risk of the cornea ulcerating or sloughing and sight being lost. A considerable percentage of the blind owe their affliction to neglected ophthalmia neonatorum. Nor are the bad effects of this disease confined to complete loss of sight from damage to the cornea: nebulæ, adhesions of the iris to the cornea (as a result of perforating ulcer), anterior polar or pyramidal cataract, and nystagmus are also all liable to result from it. By nystagmus is meant involuntary rolling or oscillation of the eyes (generally from side to side) occurring rapidly and causing considerable defect of vision. Although met with in other diseases, such as disseminated sclerosis, it is not infrequently a remote result of purulent ophthalmia, although no adequate reason can be assigned for this fact. To return to the symptoms of the ophthalmia, the lids become much swollen and congested; when they are separated a purulent discharge can be washed away, and the conjunctival surface is found to project beyond the corneal level (chemosis) and is often covered with flakes of pus and lymph. Careful attention should be paid to the state of the cornea: so long as it is clear a favourable result may be hoped for from treatment; but, if dull and opaque or ulcerated at parts, a very guarded prognosis should be given. At the same time the great vitality of the tissues in young children may result in the cornea clearing to a wonderful extent, although more or less opaque when first seen.

Purulent ophthalmia generally affects both eyes at the same time, but, f confined to one, the other should be protected by a bandage and antiseptic pad, or, in the case of adults, a Buller's shield (a watch-glass between two fenestrated pieces of strapping).

The attack nearly always lasts some weeks even when thoroughly treated; f the case progress favourably the discharge becomes more scanty and less purulent. The micrococcus of gonorrhœa can be readily found within the pus-cells by staining with methyl-blue, &c.

Treatment.—By thoroughly cleansing the eye-lids of new-born children and applying a solution of nitrate of silver (2 per cent., or rather weaker) within the conjunctival sacs, the risk of purulent ophthalmia may be to a large extent prevented; and these precautions should certainly be taken in midwifery cases amongst the poorer classes, and where there is any vaginal discharge at the time of delivery.

When an infant is brought to the surgeon with purulent ophthalmia the lids should be gently separated and all discharge washed away with pledgets of cotton-wool dipped in a weak antiseptic fluid (carbolic acid 1 in 80, Condy's fluid ℥ij to the Oj, boracic lotion, &c.), and then a solution of nitrate of silver (10 to 20 grains to the ounce) applied with a brush over the conjunctival surface of the everted lids. A weaker solution (1 or 2 grains to the ounce) may be given to the mother to use two or three times a day, and the greatest care should be enjoined to assist the free exit of pus by frequent irrigation, the lids being prevented from adhering by the use of some simple ointment. The strong astringent applications should only be made by the surgeon, at intervals of one or two days—or daily during the acute stage. In exceptional cases, when there is great difficulty in exposing the conjunctiva, the outer canthus may be divided with scissors. In gonorrhœal ophthalmia of adults the same treatment should be adopted, iced carbolic solution (1 in 60) being a valuable application in addition to those mentioned. In all cases the risk of infection from the discharge should be borne in mind, and hence sponges should not be used in washing away the discharge.

In some cases the discharge is scanty, while the swelling and infiltration of the lids are very marked, firm pellicles of lymph adhering to the conjunctiva. These cases approach what is known as diphtheritic ophthalmia, and in treating them it is as well not to use nitrate of silver, but to rely upon some other antiseptic. True diphtheritic infection of the conjunctiva is very rarely met with in this country.

3. GRANULAR CONJUNCTIVITIS,

often called granular lids or trachoma, is a very chronic and obstinate form of disease in which there is a development in the palpebral conjunctiva of little nodules of cellular deposit, of a reddish or grey colour and a semi-translucent aspect. After lasting some months they tend ultimately to disappear, but they may leave scars behind them, and often by persistent irritation of the cornea they cause it to become vascular (pannus), the new vessels lying immediately under the epithelium, and being most conspicuous in the upper half. Sometimes, however, trachoma is almost confined to the lower lid, and in that case the pannus forms in the lower half of the cornea.

Small ulcers are also liable to develop on the cornea, and attacks of muco-purulent conjunctivitis may complicate the course of granular lids.

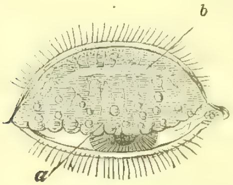

Fig. 299.—Granular upper lid. *a*, Granulations. *b*, Line of scar in typical position, parallel with border of lid.—(Nettleship.)

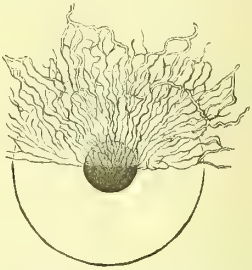

Fig. 300.—Pannus affecting upper half of cornea.—(Nettleship.)

Histologically, the granulations are found to consist of masses of lymphoid cells situated below the epithelial layer, and there seems little doubt that the true cause of the disease is a micro-organism (micrococcus of Sattler). Trachoma is especially prevalent amongst the poorer classes, and is very common in Ireland and amongst the Jewish races.

The contraction of the scars left by granulations often leads to entropion or turning in of the lid-border, and the inverted eye-lashes may then be the source of much trouble and require frequent removal. The lashes, owing to the increased vascular supply, are of exuberant growth during the active stage of trachoma, but when the latter has passed on into the stage of common scarring they often fall out and atrophy.

Treatment.—There is no eye-disease in the treatment of which more perseverance and patience are required; attempts to effect a rapid cure by scraping away the granulations or applying very strong caustics are, as a rule, very disappointing in their results. There is no doubt that the use of some astringent to the granulations is of advantage, and either the mitigated nitrate of silver stick (one part to two of nitrate of potash) or the sulphate of copper crystal is perhaps the best application. It should be used carefully to the whole granular area once or twice a week, the pain of the application being somewhat decreased by previously using cocaine, and by subsequently bathing the eyes freely with cold water. Weak astringent drops may be ordered for the patient, but it is needless to say that unless the lids are properly everted any application can have very little effect upon the granulations.

If the patient be anæmic, or otherwise out of health, iron and tonics should be given, and if trachoma should occur in a school, the greatest care should be taken to isolate the cases and to confine the use of the patients' towels, &c., to themselves.

Pure carbolic acid has lately been introduced as a good application for granular lids, but it does not appear to give better results than sulphate of copper.

The treatment of pannus.—So long as the granulations are in an active condition treatment must be directed to them, but when they have passed into the stage of scarring, and the vascularity of the corneal surface persists, special measures may require to be taken. If there is entropion it may be dealt with by making a deep groove parallel to and 3mm. inside the ciliary margin (Burows' operation), or by transplanting a bridge of skin from the eye-lid through to the conjunctival surface (Spencer-Watson's operation), or a strip of mucous membrane from the lip. Sometimes the row of displaced eye-lashes is excised, though this should be avoided if possible. If only two or three lashes are causing trouble they may be removed with epilation-forceps from time to time, or their bulbs destroyed by electrolysis.

If pannus persists independently of entropion or trichiasis (ingrowing lashes), the operation of peritomy is sometimes useful. In this a ring of conjunctiva and sub-conjunctival tissue is excised from near the cornea, and the raw surface allowed to granulate up. The resulting scar may lead to obliteration of the corneal vessels, but the operation is an uncertain one as regards its effects.

4. Chronic Conjunctivitis

Of this there are many varieties, one of the most common being met with in elderly people, and having as symptoms lachrymation, especially on exposure to the least wind, &c., moderate congestion of the eyes, and slight gummy secretion. This form, which may be termed senile conjunctivitis, is very obstinate to treatment, the most useful being, perhaps, the boracic and zinc lotion (see p. 822). At all ages, prolonged overwork of the eyes, exposure to glare and vitiated atmosphere, and uncorrected errors of refraction, may help in producing a chronic conjunctivitis or blepharitis, and in dealing with a case attention should be paid to these points.

In strumous subjects with enlarged cervical glands relapses of conjunctivitis (with formation of phlyctenules) may occur so frequently that the disease assumes a chronic form, and occasionally tubercular or lupoid conjunctivitis with more or less destruction of tissue is met with.

Obstruction to the outflow of tears through the lachrymal duct may produce chronic conjunctivitis, and requires to be treated by operative measures before the latter can be cured ; this form is more often confined to one eye than the others mentioned.

DISEASES OF THE CORNEA

Being a non-vascular tissue, exposed to various irritants from without, the corneal surface is very liable to inflame and ulcerate, particularly in subjects in weak health, and the several forms of corneal ulcer constitute a large proportion of the total cases observed in ophthalmic practice. Further, the whole substance of the cornea is liable to inflammation due to inherited syphilis (interstitial keratitis) ; and some rarer forms of corneal disease are met with secondary to iritis, cyclitis, or complicating granular lids, ophthalmia neonatorum, &c.

We may here mention the impaction of foreign bodies in the cornea, such as fragments of steel or dust. The reaction in these cases is generally severe, pain and congestion coming on rapidly ; and in such cases a careful examination should be made of the corneal surface by oblique illumination.

The detection and removal of the foreign body is much aided and rendered painless by the instillation of cocaine (2 per cent. solution applied a few times at intervals of a minute or two).

The patient's eye being steadied by the surgeon's left index finger pressing on the lower lid, the foreign body may be removed either by a corneal spud or a sharp needle; and it is often advisable to tie the eye up for a few hours after the little operation. If not found on the cornea, each lid should in turn be everted and a thorough search made for the foreign body.

1. Ulcers of the Cornea

It has already been noted that granular lids or ophthalmia neonatorum may lead to corneal ulcers: we have now to consider the primary forms of the disease. One of the most frequent is the ulcer (frequently multiple) met with most often in strumous children. Measles frequently precedes it, though any debilitating cause may lead to its occurrence. An ulcer of the cornea, however small, usually produces much photophobia and pain, and unless properly treated it may last a long time. The white scar left after it has healed is called a *leucoma*; if very faint the term *nebula* is applied. These remains of ulceration cause more or less interference with perfect vision in after-life, especially if opposite to the pupil: and if dense opacity persists, a subsequent iridectomy (performed opposite a clear part of the cornea and downwards by preference) may be of use. During the stage of active ulceration, what is seen on separating the lids is, as a rule, a whitish spot on the cornea, with a very slightly raised edge and central depression; the amount of conjunctival congestion varies considerably. As the ulcer heals a leash of new vessels may generally be seen running over the cornea to the inflamed spot. A 'phlyctenular ulcer' is vascular from the first, occasionally the ulcer is perfectly translucent, and can then be detected by the depression alone.

In bad cases the ulcer may perforate the cornea, and adhesion of the iris will then probably ensue.

Without clear evidence of strumous tendency adults may be affected occasionally with corneal ulcers, one very obstinate form being that which begins at the margins and tends to spread.

Corneal ulcers frequently relapse, or may alternate with attacks of blepharitis; they are much more common amongst the poorer classes than in the well-to-do ones.

Treatment.—The general health of the patient should be improved by attention to diet, and the administration of cod-liver oil, steel wine, or the syrup of phosphate of iron is often indicated. A shade should be worn over the affected eye, but most relief to the photophobia is derived from the use of atropine. The yellow oxide of mercury is found to have a most beneficial action in stimulating healing, and a good formula is the following:

Hydrargyri oxidi flavi	gr. viij
Atropiæ sulphatis	gr. iv
Vaselini pur.	℥ j

Ft. unguentum.

A little of this ointment is to be inserted within the lids by means of a camel's-hair brush two or three times daily. Some temporary smarting is common; but if the ointment seems to irritate, the two drugs should be used in half the proportion given above.

Fomenting the eye with warm boracic lotion is useful, but astringent applications are rarely indicated unless the conjunctivitis is intense.

Formerly one item of treatment consisted in applying a seton to the temple, but this is now abandoned, the milder measure of blistering being still occasionally employed. As soon as the photophobia is relieved, the child should not be confined to the house, but sent out with a shade on, and it is unnecessary to continue the atropine for long. The daily use of a weak yellow oxide ointment appears to promote absorption of corneal nebulæ and possibly to prevent relapses of the ulceration.

Another well-defined form of corneal ulcer is the *serpiginous* one. This is practically confined to elderly subjects, often originates in some slight abrasion, tends steadily to advance over the cornea, as well as to perforate that layer, and is so frequently accompanied by hypopyon (the deposit of pus in the anterior chamber) that it is sometimes known as the hypopyon ulcer. It may start at any part of the corneal surface, has usually a crescentic outline, and beyond the margin of the ulcer there is always considerable surrounding haze. It is of very grave prognosis as regards vision, partly on account of the risk of hypopyon and iritis, and demands energetic treatment. This consists in: (1) the very frequent application of an antiseptic fomentation (saturated solution of boracic acid, bichloride of mercury 1—3000 or 1—5000) used as hot as the patient can bear it; (2) iodoform very finely powdered, or in ointment, or pure boracic acid applied to the ulcer; (3) the administration of tonics (quinine, &c.) and generous diet. If these measures fail, or if hypopyon occurs, the ulcer should be incised right across with a Graefe's knife (this is known as Saemisch's operation, and has a remarkable effect in cutting short the progress of the disease), or the ulcer should be scraped with a very small scoop, or burnt with a fine-pointed galvanic cautery. Belladonna fomentations are useful in promoting the absorption of hypopyon; if they fail, the pus may be let out by means of a broad cutting-needle.

A troublesome form of ulcer is sometimes met with in nursing-women due to a scratch from the infant's finger, the photophobia, pain, and lachrymation being out of all proportion to the extent of the corneal lesion. These symptoms may be relieved by the application of cocaine solutions (2 to 4 per cent.) with or without atropine, by the use of belladonna fomentations, &c.

2. Interstitial Keratitis

A very chronic form of inflammation, attended by the formation of vessels and cellular deposit in the substance of the cornea, and almost invariably due to inherited syphilis. It may come on at any period from five years to thirty (or even later), and is especially common between the ages of ten and twenty. Both eyes may be affected at the same time or with an interval, and relapses are not unknown. The duration is variable, but several months generally elapse before the cornea clears to any great extent, and a nebulous condition may persist long after this. The onset of interstitial keratitis is marked by the formation of a number of whitish opacities in the cornea, or of a vascular area (frequently towards the upper or lower margin, known as the salmon patch, from its pinkish-red hue). Ulceration of the corneal surface is a very exceptional complication, but not infrequently there is some iritis, and choroiditis may develop in the affected eye either before or after the attack of corneal inflammation. Photophobia and pain are common symptoms, but are not usually very severe. After the attack has subsided, the eye is often left somewhat myopic. As already noted, interstitial keratitis is a proof of inherited syphilis in nearly all cases, but one or two have been recorded in which it appeared to result from the acquired disease. And in some not very typical cases of interstitial disease the strumous diathesis must be assigned as the cause in the absence of any evidence as to syphilis. As first pointed out by Mr. Hutchinson, the permanent teeth afford valuable evidence as to inherited taint, and especially the upper central incisors. These, in a large proportion of the subjects of inherited syphilis, are narrowed at their cutting edges, which present semilunar notches. The lateral incisors, those of the lower jaw and the canines may show similar narrowing. It is necessary to remember that the temporary or milk-teeth, as a rule, show no characteristic deformity, although they may be liable to premature decay and falling out. Other evidence as to inherited syphilis is to be obtained from the presence or history of nodes on the long bones, radiating scars at the angles of the mouth, history of snuffles and skin eruption during the first month or two of infant life, repeated miscarriages or still-births in the mother, &c. In any case where the diagnosis from the patient is doubtful, the brothers and sisters should be examined. Thus, for instance, I have seen one child affected with interstitial keratitis, and his elder brother, who had never had the corneæ affected, showed typical disseminated choroiditis. It should further be noted that the skull not infrequently presents evidence of inherited syphilis, the bridge of the nose being depressed, the forehead grooved horizontally just above the eye-brows and with a broad ridge above the groove, the palate may also be abnormally high and narrow.

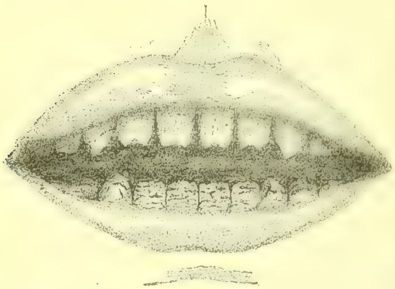

Fig. 301.—Diagram showing syphilitic teeth in the upper row, mercurial changes in the lower teeth. The upper incisors are pegged and notched, the canines pointed. The lower teeth have the enamel eroded horizontally.

Treatment.—A prolonged mild mercurial course is of benefit, and iodide of potassium is often combined with the mercury, thus:—

Liq. hydrargyri perchlor.	ʒ ss.
Potassii iodidi	gr. iij
Glycerini (or syr. aurantii)	♏ xx
Aq. dest. ad.	℥ j

If the patient is decidedly anæmic, some preparation of iron should also be given; the syrup of the iodide can be prescribed with the potassium salt.

Since iritis may occur during the course of the attack, it being often difficult to detect owing to the whole cornea being opaque, it is advisable to use atropine from time to time, and the ung. hydrarg. ox. flav. c. atropiâ is especially useful as the vascular stage subsides. It is astonishing how completely the cornea will clear in most cases; but sometimes it remains permanently opaque. Minute lines (seen with a + 20 D in the ophthalmoscope by direct examination) can be detected for years after the cornea has apparently cleared.

3. Conical Cornea

In this comparatively rare affection the cornea yields and bulges forward at its centre, whilst retaining perfect transparency, and causing considerable defect of sight which cannot be corrected by glasses. No cause is known for this mysterious disease, which usually comes on in early adult life, especially in women. Both eyes are commonly affected, and the tendency of the conicity is to increase up to a certain extent. In bad cases it can be recognised by lateral examination of the eye, but in the early stage it is best diagnosed by keratoscopy, a ring or crescent of shadow being then observed near the corneal centre. The treatment (if the defect of vision is so great as to warrant an operation) consists in excising a small piece of the bulging part, the pupil being previously well dilated with atropine for fear of anterior synechia forming.

4. Arcus Senilis

consists in a fatty degeneration of the cornea, occurring near the margin and leading to the formation of a yellowish-white ring ; it is met with in elderly people, particularly perhaps those with atheromatous arteries. It is, however, of little pathological significance, and its presence does not affect the prognosis of a cataract operation on the eye affected with it.

Epithelioma is met with as a very rare primary growth of the cornea. Lead deposits are occasionally seen as dense white patches, due to the injudicious use of lead lotion for corneal ulcers. It should be remembered that lead solutions should never be employed where there is any chance of the corneal surface being abraded, as a permanent deposit is liable to occur. The nebulæ or leucomata remaining from old corneal ulcers have been mentioned, but it may be noted that a faint nebula may interfere considerably with vision if it be central in position, and not infrequently such nebulæ are found to account for a supposed error of refraction.

DISEASES OF THE IRIS

Very occasionally melanotic sarcomata originate in the iris, cysts may develop in it (sometimes in connection with an eye-lash driven into the anterior chamber), and an interesting congenital condition is met with under the name of coloboma of the iris. This consists in an incomplete closure of the iritic circle,the gap being constantly situated in the lower (or lower and inner) part ; it may co-exist or not with coloboma of the choroid. Tubercle also occasionally affects the iris, and miliary gummata may form in it, both from acquired and inherited syphilis. These conditions, however, are all of comparative rarity and slight importance considered with regard to inflammation of the iris—iritis in its various forms.

Iritis may be due to one of many causes, the following being the chief: secondary syphilis, rheumatism, injury, inherited gout, and gonorrhœa—the first two being by far the most frequent. In addition we may note struma as a cause, although the expression is of course rather vague, and sympathetic ophthalmia includes iritis as one of its manifestations.

Iritis may be acute, sub-acute, or very insidious and chronic in its course, and hence the symptoms may differ in individual cases ; the following are the most important.

1. The pupil is not perfectly round, and does not dilate well on shading the eye, or after the application of atropine or homatropine. Small adhesions to the front of the lens are common, giving an irregular outline to the pupil, or deposits of uveal pigment may be noticed within its margin.

2. The iris is altered in colour and its reticulated structure somewhat obscured ; a greenish or grey hue is the most common, but an originally brown iris does not change much. Often minute vessels can be detected on the inflamed iris, running in towards the pupil, and sometimes nodules of lymph are developed.

3. There is congestion of the conjunctival vessels, a congestion which is not obliterated by gentle pressure ; there is more or less intense photophobia, pain in the eye itself, and pain referred to the forehead or adjoining parts. This referred pain, often localised in the distribution of the supra-orbital nerve, is to be accounted for by the fact that the sensory nerves of the iris are derived from the ophthalmic trunk.

Of these symptoms the imperfect action of the pupil to light and homatropine is the most important. Sometimes the tension of the globe is raised in iritis, and secondary glaucoma may be ultimately produced by complete adhesion of the iris to the lens (total posterior synechia), the aqueous being unable to escape from the posterior chamber and bulging the peripheral part of the iris forwards (*iris bombé*).

Syphilitic iritis occurs, with the exception of that form sometimes accompanying interstitial keratitis, during the secondary stage, and very rarely relapses. From three to six months after the chancre (in congenital syphilis at the same date from birth) is the usual time of its onset. It often affects both eyes, though commonly after a short interval, and, curiously, it may come on in the second eye whilst the patient is under mercurial treatment for the attack in the other one. It is especially in syphilitic iritis that small nodules of lymph (minute gummata) are met with in the iris, and delicate shreds of lymph may sometimes be seen in the anterior chamber. If treatment be neglected the pupil may become occluded by this lymph and practical blindness result in the affected eye ; under mercury, however, in recent cases it is speedily absorbed.

Single large adhesions are very characteristic of specific iritis ; in infants it is much more common amongst females than males, and would appear occasionally to develop *in utero*.

Rheumatic iritis comes on, as a rule, during adult life, sometimes from exposure to wet and cold, and generally a history of lumbago or articular rheumatism can be obtained. It is very prone to relapse, and the pain, congestion, and photophobia are more intense than is commonly the case with iritis due to other causes. Tough adhesions to the lens are prone to occur, but nodules of lymph are rarely seen.

Serous iritis (or kerato-iritis) is a very chronic form of the disease, characterised by the deposit on the back of the cornea (Descemet's membrane) of a number of minute dots of lymph, arranged in a triangle with its apex towards the centre of the cornea and its base at the lower border. The pain, congestion, &c., are not severe, but it is a very troublesome form of iritis to treat. The patients are commonly women, especially those of strunous tendency; serous iritis may, however, be a symptom of sympathetic ophthalmia. Peripheral choroiditis (in the form of rather faint patches) is present in many if not all cases of serous iritis.

Iritis from inherited gout is insidious but destructive in its nature, and s generally accompanied by inflammation of the ciliary body (cyclitis); the same may be said of iritis due to gonorrhœa or gonorrhœal rheumatism.

Treatment.—By far the most important measure in treating any case of ritis (so long as the attack is in the active stage) is to use atropine vigorously. An aqueous solution (four grains to the ounce), or a mixture with ten grains of cocaine in pure vaseline, should be applied within the lids at frequent intervals until the pupil is dilated so far as the case will allow. Recent adhesions will yield to the use of atropine three or four times daily, but the mydriatic has no power over old synechiæ, and its only result is then to cause irritation.

Whilst the use of atropine is most important in all cases of acute iritis, the other measures will vary according to the cause of the disease. In treating traumatic iritis, apply cold to the eye; other forms are more relieved by warm belladonna fomentations, &c. A blister on the temple sometimes relieves the pain, or leeching may be tried in the same situation. Mercury should be given in cases of acute syphilitic iritis, the dose being increased until the gums are touched. The form in which it is prescribed varies much; a convenient one is: two grains of grey powder with one of Dover's powder two or three times a day. Mercurial inunction ensures a rapid effect if performed thoroughly—but is not a cleanly method. In the treatment of rheumatic iritis salicylate of soda (in fifteen-grain doses) is sometimes useful; the bicarbonate and iodide of potassium also appear to do good. Of course exposure to draught or cold should be carefully avoided, and the affected eye should be protected by cotton-wool and bandage, &c. Dry heat appears to be particularly efficient in easing the pain of rheumatic iritis. Stimulants should be avoided; a brisk purge is often advisable in commencing the treatment, and perfect rest of the eyes in a darkened room and the use of a shade are essential in treating acute iritis. In the more chronic forms, or when several relapses have occurred, a free iridectomy upwards is sometimes advisable, one object of the operation being to keep open the communication between the anterior and posterior chambers. It should not, as a rule, be performed whilst any active inflammation is going on, or the aperture made would then be closed again by the effusion of lymph.

In treating serous iritis tonics and iron or cod-liver oil are the most useful medicines, whilst of course atropine should be employed locally.

CATARACT

This term includes many varieties of opacity of the lens, the prognosis and treatment of which differ greatly: some steadily advancing until the whole lens becomes opaque, others remaining stationary for many years and not preventing a fair amount of vision.

1. Pyramidal or Anterior Polar Cataract

onsists in a small central opacity on the anterior surface of the lens immediately beneath the capsule; it is nearly always the result of an attack of ophthalmia neonatorum (or small perforating ulcer of the cornea), has very little tendency to advance, and requires, as a rule, no operative treatment. If, however, it be large enough to interfere much with vision an iridectomy performed downwards and inwards would be indicated.

2. Posterior Polar Cataract

is often of a stellate form, is situated at the posterior pole of the lens, and is usually found in association with high degrees of myopia, or as a result of a blow on the eye. In the latter case the opacity is often of a curious punctate or wavy outline, and must be distinguished from the cases of traumatic cataract due to direct wound in which the whole lens swells and becomes opaque. Posterior polar cataract is usually very slow in progress.

3. Lamellar Cataract

is met with in early life, its subjects having nearly always suffered from convulsions in infancy, and frequently presenting what are known as mercurial teeth, *i.e.* the permanent incisors and canines are worn horizontally in grooves, the enamel being most deficient towards the cutting edges. The theory assigned for this dental malformation is that the mercury given for the convulsions leads to slight stomatitis, which affects the development of the permanent teeth. Besides the incisors and canines, the first molars are liable to show changes, the crowns being deficient in enamel, often presenting fine spicules, and wearing down early. Lamellar cataract consists in an opaque layer between the cortex and centre, both of which remain clear; the lamella affected may be so thin as to be only visible by careful focal illumination when the pupil is dilated, and vision may be but little impaired. If this be the case no treatment is advisable, but in the majority of cases a needling operation is required. Lamellar cataract is always symmetrical.

4. Senile Cataract

is that form coming on, as a rule, after forty-five or fifty years of age; it is always of the hard variety, *i.e.* suitable for extraction and not for needling operations. It may commence by a number of peripheral opaque striæ, or by a central (nuclear) opacity which slowly involves the rest of the lens. The progress of senile cataract is very variable, though perhaps in the majority of cases it becomes complete within two or three years of its commencement.

Senile cataract is, as a rule, of a white or greyish-white colour, but is occasionally amber or (very rarely) brownish-black.

We have also to note that cataract may be secondary to iritis, glaucoma or other degenerative changes in the eye, that it may occur in a lens dislocate by injury, or in connection with advanced diabetes mellitus. None of thes forms are at all favourable for operation.

Symptoms and treatment of cataract.—The first symptom of commencing cataract is dimness of vision, both for near and distant objects and the opacity is best recognised by oblique illumination in a dark room Peripheral striæ may only be detected if the pupil be first dilated wit homatropine, &c. As already stated, the rate of progress is very variable, an hence it is well not to alarm the patient by using the word 'cataract' in th rly stage. So long as one eye retains sufficient vision to enable the tient to work, any operation should be deferred. A senile cataract is condered to be ripe or ready for operation when the whole lens has become paque ; this is best estimated by observing whether during oblique illuminaon the iris shows a shadow or not on to the opaque part, *i.e.* if there is still clear part between the iris and the opacity. But there are other points be ascertained before recommending operation. Any condition of bad ealth, or the existence of inflammation of the lachrymal sac, requires to be eated before extraction can be justifiably undertaken. In the case of the tter the presence of muco-purulent discharge at the time of operation ould be almost certain to lead to suppuration of the globe. Then in a case uitable for operation the pupil should contract to light, and the patient should e able to detect the position of a lighted candle held a few feet away at various arts of the field of vision. These tests show roughly that the retina is not iseased. Cataract in highly myopic patients is not very favourable for peration, since it is often accompanied by abnormal fluidity of the vitreous, hich will tend to escape at the time of operation, and by degenerative hanges in the retina and choroid. (For the various operations on cataract, ee p. 848.)

GLAUCOMA

The essential feature of this disease is *increase of tension* in the globe, nd we may have such increase of tension resulting from iritis, swelling of he lens in traumatic cataract, &c., when it is called secondary glaucoma, or ccurring without obvious cause, when it is termed primary glaucoma. But he most important division is into the chronic and acute forms, for not only o some of the symptoms differ, but the treatment also.

There is in the normal eye a constant passage of fluid from the angle of he anterior chamber into the adjoining venous channels (canal of Schlemm, c.), and there is no doubt that one frequent cause of glaucoma is an obstrucion to the filtration at this spot. A good instance is afforded by the attack f glaucoma which occasionally is brought on by the use of atropine in lderly subjects—the mydriatic, so to speak, forcing the iris into the angle of he anterior chamber : such an attack, as a rule, is cured by the use of eserine, hich, by contracting the pupil, draws the iris away from the angle. Glauoma is more common after middle life than before, and we may associate ith this the fact that as age advances the lens becomes relatively larger, nd may therefore help in causing obstruction to the outflow (Priestley mith). There is, however, a curious form of glaucoma known as buphthalos, met with in children, in which the whole eye is enlarged, hard, and e anterior chamber deeper than normal. Chronic inflammatory processes the ciliary region are also an important cause of glaucoma.

1. Acute Glaucoma

much more common amongst women than men, and is especially prone to cur after the age of forty-five. Whilst no cause can be assigned in many ses, in some it appears to be due to excessive use of the eyes, severe ntal emotion or shock. The subjects are nearly always hypermetropic, ute glaucoma being decidedly rare in myopic eyes. Certain premonitory signs often precede the acute attack: rapid increase of presbyopia, passing congestion of the eye, coloured rings seen by the patient around a distant light, being the usual ones. The sight then becomes rapidly worse, the patient complains of seeing objects obscured as though by a fog, there is intense pain in the eye and forehead, and frequently sickness accompanies the pain. On examining the eye, marked congestion, with often œdematous swelling of the conjunctiva (chemosis) is found, the pupil is somewhat dilated and responds badly to light, the anterior chamber is shallow (as a rule), the media hazy. The cornea may be so 'steamy' that no view of the fundus can be obtained; but, if the disc can be seen, the veins are found to be engorged, and there is arterial pulsation. The visual field is much narrowed, the inner side going first.

Mistakes in diagnosis are often made, the sluggish pupil suggesting iritis, or the congestion and chemosis may be thought to be simple conjunctivitis, or the vomiting and headache may be mistaken for a 'bilious attack.' The essential point in the diagnosis consists in estimating the tension of the globe: this is done by placing the two index fingers on the upper lid as the patient looks down; gentle downward pressure is then made with one finger, and the resistance of the eye felt by the other. Some surgeons use the index and middle finger of one hand in estimating tension. The two eyes should always be tried, and only practice will enable the student to estimate slight degrees of increase. In acute glaucoma, however, the abnormal hardness of the globe is very easily recognised.

Prognosis and treatment.—If acute glaucoma be neglected, the eye becomes rapidly and permanently blind. Irretrievable damage to the retina may be done in a few days; on the other hand, if the disease be early recognised and treated, a most satisfactory result is usually obtained. As soon as possible a free upward iridectomy should be performed (see p. 847), though as a temporary measure eserine drops (two grains to the ounce) may be used. Eserine (and pilocarpine to a less extent) has a great effect in reducing tension of the eye, and in a few cases its use may obviate the necessity for operation; but it may be repeated that the treatment for acute glaucoma is iridectomy, which is often followed by complete and permanent restoration of sight. In many cases, however, only partial success results from the operation, because it has been too long deferred, and in a few severe retinal hæmorrhage follows it, or the glaucomatous symptoms may recur after a time.

2. Chronic Glaucoma

comes on gradually and is characterised by less congestion of the eye, pain, &c., than the acute form. The pupil may be but little dilated and the media may be fairly clear, the disc in an advanced case is seen to be deeply cupped (the vessels curving sharply round its margin) and atrophied. Venous (and with slight pressure on the globe, arterial) pulsation is present in the vessels of the disc. The field is either concentrically contracted or irregularly limited—especially on the nasal or inner side. Attacks of 'fog or mist before the eyes' and of haloes round a light are often complained of, and the sight steadily deteriorates. The rate of progress is, however, very uncertain in different cases.

The treatment consists in avoiding over-use or strain of the eyes; the patient should be provided with proper glasses; tonics and laxatives may be useful, and a weak solution of eserine ($\frac{1}{8}$ to $\frac{1}{2}$ grain to the ounce) should be dropped into the eye once or twice daily. Pilocarpine (one to two grains to the ounce) may be used instead of eserine. By these means a patient with chronic glaucoma may retain moderate vision for a long time, but in some cases the best chance is offered by a free iridectomy. If the tension should continue or return, a second iridectomy or a sclerotomy may be useful. It is necessary that the patient's age and state of health should be taken into account before recommending operation, especially as chronic glaucoma is prone to occur in those who are of feeble or worn-out constitution.

One danger of the operation may here be mentioned—that of wounding the lens—in which case a traumatic cataract will inevitably follow. The risk of it is much less if a Graefe's knife be used instead of a keratome.

DISEASES OF THE OPTIC NERVE AND RETINA

1. Optic Neuritis

The optic nerve may be inflamed at various parts—for instance, there is such a thing as retro-bulbar neuritis, in which the nerve is affected behind the globe; but what is always understood as optic neuritis is inflammatory swelling of the optic papilla or disc. There is no doubt that in most cases the inflammation is transmitted from the intracranial portion of the optic nerve to its intra-ocular expansion, and of all the morbid lesions which may set up optic neuritis, perhaps the most certain is basic meningitis. It will be remembered that both the dura mater and pia mater are directly continuous with the sheath of the nerve. It does not matter, so far as the optic neuritis is concerned, what is the primary cause of the meningitis—a syphilitic gumma of the meninges, tubercle, traumatism, and cerebral abscess being the most frequent. Another common cause of optic neuritis is cerebral tumour, the exact locality of the latter being immaterial. Thus, a growth in one occipital lobe may produce double optic neuritis as surely as one at the base of the brain. Important as is the neuritis in the diagnosis of cerebral tumour, it is not a constant symptom, and may develop early or late in the course of the disease.

Certain morbid states of the blood and vascular system may produce optic neuritis, *e.g.* secondary syphilis, anæmia or leucocythæmia, gout, diabetes, lead-poisoning, albuminuria, and the high vascular tension that accompanies hypertrophy of the heart and chronic nephritis. In all these latter forms the retina and sometimes the vitreous participates in the inflammation, which is really a neuro-retinitis. Optic neuritis is nearly always symmetrical, using the term in a wide sense, but occasionally it remains confined to one eye. It is a curious and important fact that intracranial hæmorrhage by itself hardly ever leads to optic neuritis. Severe concussion of the brain occasionally does so, the neuritis being then, as a rule, of a slight and transitory nature.

Symptoms, &c., of optic neuritis.—The subjective symptoms are variable, sometimes there is pain at the back of the eyes or frontal headache; there is generally considerable defect of vision—but this may be absent even in a case of severe neuritis. A sense of 'flickering before the eyes' is often noticed in the early stage. The ophthalmoscopic evidence is alone decisive.

The optic disc is swollen and blurred, its edges more indistinct than normal, the vessels are obscured in their course and bend suddenly at the edge of the swelling. Small hæmorrhages are frequently present, especially near the macula in cases of albuminuria or diabetic neuro-retinitis, often accompanied by white patches due to exudation into and degeneration of the retina. By the direct examination the swollen optic papilla is best seen with a + glass in the ophthalmoscope, and by estimating the highest lens with which the details are made out, some measurement of the degree of swelling can be obtained. Optic neuritis may clear off completely and vision be perfectly regained, but the usual tendency of old cases is to pass on into atrophy of the nerve. This is told by the abnormal whiteness of the disc, the diminution in size of the retinal vessels, and the white lines which run along their borders. In primary atrophy (*i.e.* where neuritis has not preceded it) these white peri-vascular lines are not observed; nor, as a rule, are there any changes about the macula.

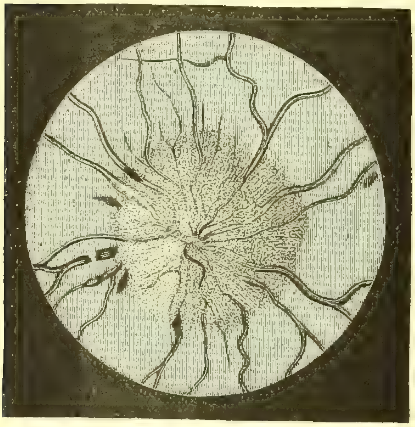

FIG. 302.—Ophthalmoscopic appearance of severe papillitis. Several elongated patches of blood near border of disc. (After Hughlings Jackson.)

The diagnosis of optic neuritis requires care and experience in the use of the ophthalmoscope, and certain conditions of the eye may give rise to mistake. Thus, in high degrees of hypermetropia the disc often looks pinker than normal, and the papilla is of course seen best with a + lens by the direct method; but the vessels are not at all obscured. Opacities in the vitreous may cause the disc to appear blurred, but there is no swelling of the latter. It is important to remember that the neuro-retinitis due to cerebral tumour, &c., may present the features characteristic of albuminuric retinitis—hæmorrhages and white spots in the region of the macula.

The treatment of optic neuritis must depend upon the cause: if due to syphilis, mercury and iodide of potassium must be freely administered; if to anæmia, iron and aperients must be given. As a rule the eyes should be protected from the light, stimulants should be forbidden, and if the patient is able to go out he should wear protective goggles. Without going into the medicinal treatment of albuminuric retinitis, it may be stated that it is a symptom of grave prognosis with regard to the patient's life, most of the cases ending fatally within a year or two of the time at which the eye-affection is noticed.

2. OPTIC ATROPHY

As already stated, this may be the result of optic neuritis, or may be primary. If the latter, it is most often a symptom of tabes dorsalis, and in any case absence of knee-jerks, the history of 'lightning-pains,' &c., should be investigated. One frequent symptom of tabes is what is known as the 'Argyll-Robertson' pupil, the pupils not contracting on exposure to light, but acting when the ciliary muscle contracts in accommodation for near objects, or, in other words, when the eyes converge. Inequality of the pupils also is frequently met with in tabes. Optic atrophy, like optic neuritis, is generally but not always symmetrical, one exception being the atrophy which occasionally results from a severe injury to the forehead or vertex. In these cases it is probable that the optic nerve is crushed or torn by a fracture of the base passing through the optic foramen. Another instance of unsymmetrical optic atrophy is that due to embolism of the arteria centralis, and in some cases no cause can be assigned. Tertiary syphilis and disseminated sclerosis may be mentioned as occasional causes of symmetrical atrophy, though in the former case there are usually other symptoms of tabes.

Gradual failure of vision, both near and distant, and progressive limitation of the fields for white and colours, are the chief symptoms of optic atrophy, apart from the pallor of the disc and shrinking of the retinal vessels already mentioned. The treatment chiefly turns upon the presence or absence of syphilitic history; if there is any evidence in favour of syphilis a careful trial should be given to iodide of potassium, combined with nux vomica. But the prognosis of optic atrophy in any case is extremely unfavourable.

3. Tobacco-Amaurosis

This important disease appears to depend upon a chronic inflammation of a certain tract of nerve-fibres which go to the macular or central region

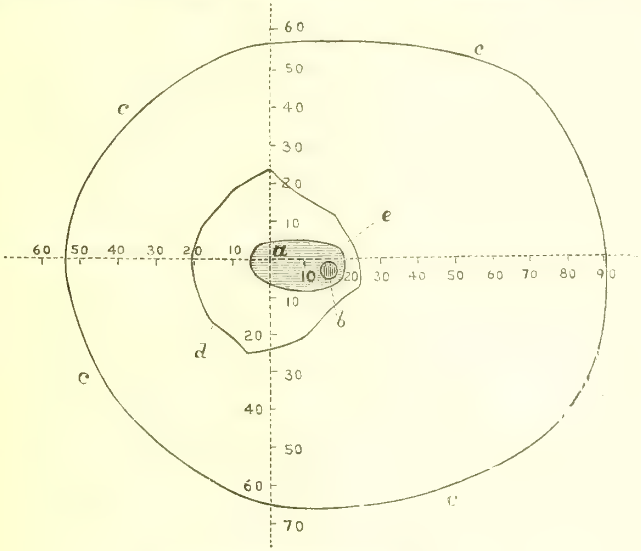

Fig. 303.—Field of vision for right eye.

a. Fixation point. *b.* Area corresponding to optic disc (blind spot). *c.* Normal field for white. *d.* Field from a case of retinitis pigmentosa (concentric limitation). *e.* Area (including fixation and blind spots, shaded horizontally) represents the scotoma for red and green in a case of tobacco-amaurosis.

of the retina. There is nothing to be seen ophthalmoscopically except some degree of atrophy (in advanced cases) of the outer part of the disc. The defect of vision, by the time the patient usually comes under care, is very marked and is nearly invariably symmetrical, *e.g.* $\frac{6}{60}$ and 14 Jäger type. On inquiry the patient is often found to have made mistakes lately between silver and copper coins, and on testing with the perimeter and small squares of coloured paper, his visual field presents a scotoma or blind area for red and green, less commonly for yellow, and very rarely for blue (see fig. 303, *e*).

The field for white is not limited, nor that for colours apart from the scotoma. Individual idiosyncrasy to tobacco must be taken into account, but practically it is only the strong dark sorts (shag and cavendish) that produce tobacco amaurosis. Provided the case come under care fairly early, and the patient be persuaded to give up smoking, the prognosis is very good ; but under other circumstances more or less defect will be likely to persist. Tincture of nux vomica in small doses (♏ v ter. die) appears to hasten recovery.

4. Retinitis Pigmentosa

This rare disease is characterised by the development in the retina of black pigment, which lies superficial to the retinal vessels in the form of a ring or belt in the periphery. This ring of pigment is made up of reticulated and dotted patches which often have processes connecting them (like the bone-corpuscles as seen under the microscope). This development of pigment is attended by atrophy of the optic disc and retina and steady deterioration of sight. The first thing commonly noticed is failure of vision in the evening (night-blindness)—and soon the visual field is found to be contracted, the tendency of the disease being to progress slowly for some years. No treatment is known to have much effect in checking it, though galvanism with the constant current is worthy of trial.

It should be remembered that syphilitic retino-choroiditis may simulate retinitis pigmentosa, but the former is not so closely symmetrical, usually shows patches of choroidal atrophy as well as the pigment ones, and in it the night-blindness and narrowing of the field are rarely so decided. True retinitis pigmentosa comes on, as a rule, in early adult life, and certainly is most prevalent in the offspring of consanguineous marriages.

5. Retinal Detachment, &c.

In highly myopic subjects a slight blow on the eye or a straining effort may lead to detachment of the retina, especially its lower segment. Sometimes it is spontaneous, and is a not uncommon sequence of chronic inflammatory changes in the ciliary region and vitreous. Supposing fair vision to have been present before the detachment occurred, the patient notices a sudden loss of sight in the affected eye for objects above the horizon (or, if the detachment be total, for all objects). On examination with the ophthalmoscope the retina is seen to come right forward as a whitish, often furrowed, projection, over which the vessels course. This appearance is very characteristic, but may be simulated by what is known as pseudo-glioma. The latter is nearly always met with in children, and consists in inflammatory exudation masses in the retina and vitreous ; there is no such regular arrangement of vessels as in the case of simple detachment. A true glioma or glio-sarcoma may also lift up the retina ; but in this case the tension of the globe is generally increased (in simple retinal detachment usually the eye is soft). It is of course important to diagnose a gliomatous tumour, since excision of the eye must be resorted to, and in any case in which there is much doubt the solid nature of the swelling can be ascertained by means of the electric light used in a special instrument.

No treatment, unfortunately, is of much avail in cases of retinal detachment.

Hæmorrhages into the retina and vitreous are sometimes met with in young adults, inherited gout and constipation being the chief factors in their causation. In such cases the use of purgatives, rest to the eyes, and the administration of iodide of potassium, &c., may be followed by gradual absorption of the blood and recovery of vision. In older subjects multiple retinal hæmorrhages with optic neuritis are generally due to high arterial tension and vascular degeneration, and are of very grave prognosis.

DISEASES OF THE CHOROID

We have to consider briefly: (1) the various forms of choroiditis; (2) tuberculosis; and (3) tumours of the choroid.

1. Choroiditis

may be either central or peripheral, and may occur in large patches or as very minute spots, being often associated with changes in the retina immediately overlying it. Speaking roughly, it may be said that the great majority of cases of choroiditis are due to syphilis, either acquired or inherited. The most typical form of the specific disease, coming on several months or years after infection, consists in well-defined white patches with black pigmented borders, scattered about the periphery of the fundus. Sometimes the pigment predominates, and at others a single large patch at or near the macula is found. The latter may represent an absorbed gumma, or may be very superficial and tend to spread in the aggressive manner we observe in syphilitic lupus of the skin. The more the central or macular region is affected the greater is the risk of permanent damage to vision, changes confined to the periphery not necessarily producing much defect of sight. Since many cases only come under care when the active stage is long past, treatment is often not of marked benefit, but a thorough course of the iodides and mercury is advisable under other circumstances.

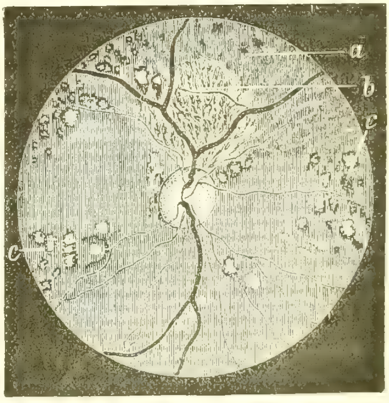

Fig. 304.—Atrophy after syphilitic choroiditis, showing various degrees of wasting (Hutchinson). *a.* Atrophy of pigment-epithelium. *b.* Atrophy of epithelium and chorio-capillaris, the large vessels exposed. *c.* Spots of complete atrophy, many with pigment accumulation.

Associated with myopia we find atrophic white choroidal patches in the macular region; with general senility, numerous small round light areas, also chiefly central in distribution. A pigmentary form of retino-choroiditis following concussion of the eye has already been alluded to, and linear ruptures of this layer are not infrequent from the same cause.

2. Tubercle of the Choroid

is distinguished by the ophthalmoscope as ill-defined, light, raised patches, as large as, or larger than, the optic disc. It is nearly always a sign of advanced general tuberculosis, especially when the meninges of the brain are affected, and is decidedly a rare affection.

3. Tumours of the Choroid

Melanotic sarcoma is the most frequent primary growth, and there is the same tendency to rapid general infection through the blood as in melanotic sarcoma starting in the skin. Nevertheless, if the eye containing the tumour be excised early, a radical cure is possible. These sarcomata are composed of spindle and round cells, occasionally non-pigmented; in all cases the tumour tends to project into the vitreous, as well as to invade the sclerotic and orbital tissues. Glioma, starting in the eye, grows backwards along the optic nerve to the brain, and is more common in childhood than is sarcoma of the choroid. The latter may be recognised ophthalmoscopically, before it has protruded through the sclerotic; it often commences at or near the ciliary region, and pushes the iris somewhat forwards, whilst increasing the tension of the globe.

Excision of the eye is the only treatment, and the earlier it is done the greater the chance of non-recurrence.

PARALYSIS OF THE OCULAR MUSCLES, *&c.*

It will be remembered that the intra-ocular muscles, the ciliary one and the contractor pupillæ, are supplied by the third nerve, which also controls all the extra-ocular muscles moving the globe, except the external rectus (sixth nerve) and the superior oblique (fourth). In the case of syphilitic or traumatic meningitis all the nerves in the wall of the cavernous sinus may be involved (the sixth being the most likely to escape), whilst from nuclear disease one or other muscle may be paralysed or only the intra-ocular ones (ophthalmoplegia interna). As other causes of ocular paralysis, we may mention tumours or aneurysms at the base of the brain, fractures of the skull, and tabes dorsalis. Fairly often we observe temporary paralysis of one or other muscle (including the levator palpebræ) in those affected with the last-named disease.

If the paralysis of one of the muscles moving the eye be complete, it is revealed by squint or strabismus, especially on trying to bring the affected muscle into action; but slighter degrees are marked by diplopia or double vision on the part of the patient, although perhaps no defect of movement can be detected by the surgeon. If one of the external or internal recti be alone paralysed, the double images are seen vertically placed; but if either of the other rotator muscles, the false image (that seen with the affected eye) is inclined. Such cases are best examined by holding a lighted candle before the patient (at a distance of several feet) in a darkened room, and moving it in various directions, the patient following it with his eyes, and stating the relative position of the two images to each other. The treatment consists (whenever there is reason to suspect syphilis) in the administration of iodide of potassium.

What is known as diphtheritic paralysis of the eye consists in a failure of accommodation (symmetrical) coming on rather suddenly within a few weeks of an attack of diphtheritic sore-throat. Distant vision (supposing the patient to be emmetropic) is unaffected, but it becomes impossible to read small print without convex lenses corresponding to the amount of accommodation lost. The 'knee-jerks' are absent, and there is frequently some paralysis of the soft palate revealed by regurgitation of fluids into the nose. Complete recovery nearly always ensues in the course of a few weeks, and is probably hastened by tonics, country air, and other measures to improve the general health. It is a curious fact that in some of the most marked cases the sore-throat has been but of slight intensity.

Weakness of the internal recti, and of the ciliary muscle ('muscular asthenopia') is frequently observed in anæmic subjects or those weakened by prolonged lactation, exhausting illness, overwork, improper food, &c. In high myopia the strain of convergence leads to defect of power in the internal recti, and divergent squint may result. The use of proper glasses, of prisms with their bases inwards, and finally the advancement of one internal rectus, are some of the means employed to remedy the defect; but the details cannot be given here. It may be noted that many cases of strabismus are not accompanied by double vision, owing to the obliteration of the image received in the squinting eye, and that the majority of cases of convergent strabismus do not depend upon paralysis of any muscle, but upon over-action of the internal recti.

DISEASES OF THE EYE-LIDS, ORBIT, &c.

The lax tissue of the eyelids is especially prone to œdematous swelling, sometimes the remains of an attack of facial erysipelas, more often a sign of general want of tone, of senility, or of more serious visceral disease. Occasionally we meet with persistent œdema of the lids for which no cause can be assigned, or which has started in some long past erysipelatous affection. Abscess of the lid is a not uncommon complication of facial erysipelas, and should be incised as early as possible; occasionally it is due to an embedded foreign body. There is considerable risk of an orbital abscess finding its way backwards into the skull, and sudden death may result from this, hence the importance of opening and draining any collection of pus in this situation. An exploration can readily be made with a sharp tenotome introduced parallel to the orbital roof or floor.

BLEPHARITIS (OR SYCOSIS TARSI)

is the name given to inflammation of the lid-margins of an eczematous nature. There may be small ulcers along the lid-borders, or simply pustules and crusts, the hairs tending in old cases to atrophy and fall out. In some cases the hair-bulbs form the centres of small pustules, and it is for these that regular epilation with forceps is advisable; when the blepharitis is more of an eczema than a sycosis it may usually be cured without resorting to this painful measure.

The disease is most common in children, often follows an attack of measles or scarlet-fever, and is very chronic in its course. It may also be set up in adults by prolonged overwork of the eyes in ill-ventilated rooms, and sometimes is associated with uncorrected errors of refraction.

There is more or less gummy discharge and lachrymation, the lids adhere together on waking up, and the condition is aggravated by exposure to cold winds, &c. A large proportion of its subjects are anæmic or show signs of scrofulous tendencies. The treatment is satisfactory if the case be seen early, but when blepharitis has existed for long it becomes well-nigh incurable. All scabs should be removed twice a day by free bathing with warm water (or a lotion containing five or ten grains of bicarbonate of soda to the ounce), and a stimulating ointment (the ung. hydrarg. nit. dil., or the ung. hydrarg. oxidi flavi) applied to the edges of the lids. Sometimes an astringent lotion (see treatment of conjunctivitis) suits well, and the application of a twenty-grain solution of nitrate of silver from time to time may be useful. Any decided error of refraction should be corrected; if there is photophobia, the use of cobalt-tinted protective glasses, or of 'goggles,' is advisable. Cod-liver oil should be given in the strumous cases and preparations of iron in the anæmic ones. Sometimes, as already mentioned, it is necessary to epilate or to apply the mitigated nitrate of silver stick from time to time to the little sores.

Lachrymal Obstruction

The chief symptom of impeded passage of tears into the nose is *epiphora*, or their flowing over the cheek. The obstruction may be situated at the puncta (or the latter may be displaced owing to entropion or ectropion), in the canaliculi, lachrymal sac, or nasal duct. If it is in the latter, pressure over the sac with the finger will cause a sudden regurgitation of fluid (more or less mucoid or even purulent) through the puncta. This distension of the sac (*mucocele*) by retained mucus and tears can often be seen as a rounded swelling at the inner canthus; it is always liable to set up inflammation and suppuration, and if the abscess is allowed to burst it commonly does so below the tendo oculi. A fibrous stricture of the nasal duct is not infrequently the cause of lachrymal obstruction, being itself probably due to some chronic inflammation of its lining mucous membrane. Disease of its bony wall (*e.g.* from inherited syphilis) may also give rise to most intractable lachrymal obstruction.

In cases of chronic conjunctivitis with epiphora, but without mucocele or other evidence of organic obstruction, astringent drops or lotion (two grains of nitrate of silver or sulphate of zinc, or one grain of chloride of zinc to the ounce) are of use. If there is displacement of one or both puncta or narrowing of the duct, considerable advantage is gained by slitting up the canaliculus with a Weber's probe-pointed knife. The lachrymal duct can then be explored by probes, any stricture dilated, and frequent irrigation employed. It must, however, be admitted that the gradual dilatation of these strictures is commonly very unsatisfactory, even when aided by the frequent use of astringent and antiseptic lotions, and somewhat better results are obtained from introducing a leaden style (the upper end of which is bent down so as to prevent it slipping right in), which is worn for many months at a time. Boracic or weak sulphate of zinc lotion should also be used.

SYPHILITIC AFFECTIONS OF THE LIDS

Primary chancres are occasionally met with both on the conjunctival and cutaneous surfaces; they are always accompanied by pre-auricular or submaxillary buboes, the presence of this gland-enlargement assisting greatly in the diagnosis. During the secondary stage, especially if there is a well-marked eruption on the face, a syphilitic form of blepharitis with multiple small ulcers along the lid-borders is sometimes observed. Tertiary ulceration of the eyelids is noteworthy from the fact that it is difficult to cure by the ordinary treatment (iodoform locally and iodides internally), and is very prone to relapse. It is a rare disease, the subjects being usually women who have suffered severely from other syphilitic symptoms.

TUMOURS OF THE EYE-LIDS AND ORBIT

By far the most common is what is known as a *meibomian cyst* or *chalazion*. It occurs (usually in young or middle-aged adults) as a small, rounded, well-defined lump in the eye-lid, which really starts in the meibomian gland layer, but tends to project most towards the skin. Sometimes more than one is present at the same time, and there is a tendency for them to recur in certain individuals. They consist of a gelatinous mass of small cells situated around one of the meibomian glands, and though they may sometimes remain quiet for long, tend, as a rule, to inflame and suppurate. Hence it is advisable to operate on them as soon as they attain a sufficient size to be easily recognised by the finger passed over the affected lid. The latter should be everted, the conjunctival surface over the tumour treated with pure cocaine to procure anæsthesia, then a small crucial incision made with a Beer's knife, and the little tumour evacuated by means of a small curette and finger-pressure. If the cyst has already suppurated, an incision alone will suffice.

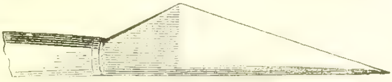

FIG. 305.—Beer's cataract-knife.

A stye consists in inflammation and suppuration about one of the sebaceous glands at the edge of the lids. As is the case with meibomian tumours, there is usually a strong tendency to recur. Hot fomentations and a small incision to let out the pus constitute the local treatment; any accompanying conjunctivitis or error of refraction should be attended to, and a tonic is often useful.

Horns are occasionally seen growing from one or other eyelid; they invariably originate in a sebaceous gland, and, however hard towards the apex, are fairly soft at their base. Excision with scissors is required.

Nævi are common about the eye-lids as elsewhere on the face; the cutaneous purple ones should be treated with a very fine cautery point (the galvano-cautery wire-loop is suitable) or by electrolysis. The advantage of the latter is the subsequent absence of scarring, but it is a slow and rather uncertain method. The most difficult form to treat is the large subcutaneous venous nævus, which may cause the affected eye-lid to constantly project over the eye. Repeated punctures with the fine point of the Pacquelin's cautery form the most satisfactory treatment, an interval of a few weeks being allowed between each application.

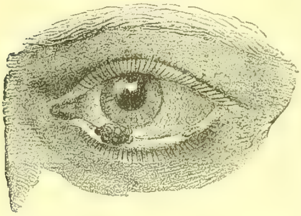

FIG. 306.—A small melanotic growth on the lower eye-lid, commencing in a mole.

A form of congenital growth occasionally met with at the edge of the eye-lids is the pigmented mole, forming a small lobulated excrescence. It is of importance from the risk of melanosis starting from it in later life, and hence should be excised.

Molluscum contagiosum is treated in the section on Diseases of the Skin. A favourite starting-place for *rodent ulcer* is the inner part of the upper or lower eye-lid. It commences as a small, smooth infiltration of the skin, and tends to have a crescentic outline and to ulcerate sooner or later, then steadily advancing both in depth and on the surface. It may occur as early as thirty years of age, but is most common in more elderly patients, and, as is well known, causes no glandular enlargement, however long it exists.

The best treatment is excision, scraping or cauterisation being more likely to be followed by recurrence, unless very thoroughly done.

Dermoid cysts occur as rounded subcutaneous tumours, especially over the external angular process of the frontal bone, which is often slightly indented beneath them. They are always congenital and due to peculiarity in development, and do not as a rule increase much after the first year or two. They have a fibrous wall lined with epithelium, their contents being chiefly sebaceous matter, cholesterin, and abortive hairs. If prominent enough to be unsightly, the cyst should be excised (without opening the cyst-wall during the operation, if it can be avoided), the wound being made parallel to the eye-brow and carefully sutured with fine silk. A spirit lotion or iodoform should be used in the dressing.

PULSATING ORBITAL TUMOUR

This term includes several conditions, producing the following symptoms: (1) protrusion of one eye (occasionally of both) with dilatation of its superficial veins; (2) pulsation to be felt in the orbit, generally best through the upper lid; (3) a continuous bruit, which is not only readily heard by the surgeon but gives great annoyance to the patient; (4) frequently paralysis of one or other oculo-motor muscle. Although the pathology of this affection is still not completely ascertained, it is certain that the most usual condition is a great dilatation of the ophthalmic vein (due in most cases to a communication with the internal carotid artery in the cavernous sinus).

More rarely a true aneurysm of the carotid or ophthalmic arteries is present.

Pulsating orbital tumour, like arterio-venous aneurysm elsewhere, is generally the result of injury—a fall or blow on the head involving fracture of the base, a punctured wound of the orbit with a sword or stick, &c.—and is therefore most common in males. It develops gradually within a few weeks of the injury, the symptoms increasing in severity until sometimes vision is lost, owing to the extreme protrusion of the globe and stretching of the optic nerve. In some cases it arises independently of any injury, and this spontaneous form is usually of sudden onset and is most common in females.

It is an interesting fact that, however great be the protrusion (*proptosis*), the vessels of the optic disc present but little that is abnormal, beyond pulsation of the veins. As already mentioned, however, the veins of the conjunctiva and lids are usually much dilated.

The progress of the disease is variable; a gradual diminution of the protrusion and spontaneous cure is possible, though most of the cases are submitted to treatment. This consists in: (1) digital compression of the common carotid, which unfortunately can only be carried out for short periods, owing to the pain it causes; (2) the use of ice or graduated compression over the globe and eye-lids; (3) ligature of the carotid artery. Attempts have been made more than once to ligature the dilated vessel in the orbit, but have almost always failed.

Tying the common carotid has been followed by cure in a fair proportion of cases, but it is a proceeding attended with serious risk, and should not be resorted to unless milder measures have failed and the symptoms are steadily increasing in severity.

XANTHELASMA PALPEBRARUM

consists in the development of raised yellow patches at the inner end of the eye-lids, especially the upper ones. Its subjects are always adults, especially those who have suffered repeatedly from 'bilious attacks' or sick headaches. The yellow colour is found to be due to a peculiar fat which is deposited in the rete mucosum cells or the corium immediately beneath. It rarely happens that a xanthelasma patch is sufficiently disfiguring to call for its excision.

OPERATIONS

The introduction of cocaine has greatly limited the use of ether and chloroform in ophthalmic surgery; general anæsthesia is now only required, as a rule, for excision of the globe, tenotomy in young children, advancement of a rectus, and iridectomy for glaucoma. Extraction of cataract can nearly always be effected under local anæsthesia, and thus the risk of after-vomiting avoided, but occasionally it is necessary to give ether or chloroform if the patient be very restless or possess no self-control. To obtain local anæsthesia of the cornea and ocular conjunctiva, the best way is to drop on to them a 2 per cent. solution of freshly prepared cocaine (made with some boracic acid in it for the purpose of antisepsis) several times during the ten minutes which precede the operation. It must be remembered, however, that the cocaine does not anæsthetise the lid-borders nor the iris, hence the introduction of a speculum and iridectomy cause slight pain. In doing extraction of cataract with iridectomy it is well to warn the patient of this before introducing the iris-forceps, for fear that a sudden movement should endanger the success of the operation.

Hypodermic injection of a few drops of cocaine solution may be used in performing tenotomy or excising part of the eye-lid, &c.; and, for the removal of a meibomian tumour or applying astringents to the conjunctiva, anæsthesia is best procured by applying powdered cocaine and allowing it to dissolve locally.

1. Excision of the Globe

Instruments required: spring speculum, fixation-forceps, scissors curved on the flat, strabismus-hook. Standing behind the patient, introduce and fix the speculum, pick up the conjunctiva just above the cornea, and divide it all round close to the sclero-corneal junction. Having opened Tenon's capsule, introduce the hook under each of the recti muscles in turn and divide them. Then open the speculum as widely as possible, press it backwards and make the globe protrude. Steadying it with the fingers of the left hand, introduce the scissors behind the globe from the right-hand side, open them to receive the optic nerve within the blades, and divide it with a single cut. One or both oblique muscles and some connective tissue may still require to be divided. A small sponge should be at once applied and kept in place by a pad and firm bandage. The wound heals usually within a week, and about a month after the operation a glass eye may be worn. It is well to use some boracic lotion and ointment daily for a week or two after the operation.

Lately the introduction of small celluloid glass or silver globes within Tenon's capsule, to take the place of the excised eye, has been extensively tried. The capsule and conjunctiva should be sewn up separately with fine silk, and it is well to use a drain of horsehair for a day or two. If the operation succeeds the movements of the glass eye are generally improved by the presence of the globe behind it, but unfortunately there is a strong tendency on the part of the latter to work out.

A glass eye should be removed every night and cleansed, and it needs to be renewed, as a rule, once a year.

2. Tenotomy

(The common operation—division of the internal rectus—will be described.) The operator stands at the right side of the patient, introduces the speculum, and seizes a little fold of conjunctiva with the fixation-forceps—the point aimed at being the junction of the inner and lower corneal tangents. With a small pair of straight scissors he makes an opening in the conjunctiva and Tenon's capsule at the same time. If this is not done the capsule should be picked up separately and incised. The strabismus-hook (which should always be blunt-ended) is now passed with its end directed backwards towards the apex of the orbit, then brought under the rectus tendon, and the latter slightly raised on the hook, whilst one blade of the scissors is introduced under it, the other passing between the conjunctiva and tendon. The latter is now cut through, and the hook may be reintroduced if it is thought some part of the muscle has remained undivided. A pad and bandage are usually applied for a few days—the conjunctival wound is so small that no suture is required.

It is never advisable to perform tenotomy on both eyes at a time, for fear divergence should result. Squints of 25° or more will not be cured by a single tenotomy; but it is best to perform the second operation after a considerable interval; of course all errors of refraction should be corrected.

Sometimes tenotomy of one muscle is combined with advancement of its opponent, *e.g.* for divergent strabismus the external rectus is divided and the internal one advanced. The operation of advancement is too complex to be described here.

3. Iridectomy

As already described (p. 820), in cases of wound of the globe with prolapse of the iris, an iridectomy may be required. Apart from this it is performed either for optical purposes (*i.e.* to provide an artificial pupil in cases in which the natural one is hidden by a corneal nebula or obstructed by lymph), or to facilitate the extraction of cataract. In either case only a small iridectomy is generally made. But in the case of iridectomy for glaucoma it is necessary to remove a large portion of the iris and to take it right up to the ciliary attachment (see fig. 308).

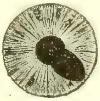

Fig. 307.—Iridectomy downwards and inwards for artificial pupil.

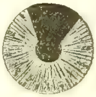

Fig. 308.—Iridectomy for glaucoma (De Wecker).

Iridectomy for optical purposes is made by choice downwards or downwards and inwards; but its position must, of course, depend on that of the clear part of the cornea. Iridectomy for glaucoma is nearly always performed upwards, so that the coloboma may be concealed to some extent by the upper lid. In doing the former a keratome is usually employed, whilst many prefer Graefe's knife for the latter operation. There is a certain amount of risk in using the keratome that the lens-capsule may be wounded, though this does not often happen.

The operation for glaucoma may be briefly described. An anæsthetic is advisable. The speculum having been introduced, the conjunctival surface is cleansed with boracic lotion. The operator, standing behind the patient, fixes the globe by grasping the conjunctiva with the forceps below the cornea, and then with a broad keratome or a Graefe's knife makes an incision about 1mm. behind the sclero-corneal junction, equal to nearly one-third of the corneal circumference, and just in front of the attachment of the iris. The instrument is slowly withdrawn, the escape of the aqueous causing the iris to bulge towards the wound. A pair of iris-forceps is now introduced, opened, and made to seize the iris towards its pupillary border, the assistant having taken charge of the fixation-forceps. The iris is now drawn out and cut through at the right-hand margin of the wound; by gentle traction it is torn away from its ciliary attachment as far as the left-hand border of the wound and again divided. A fine caoutchouc spatula or curette is now used to depress either border of the iris from the wound, any blood is gently wiped away with cotton-wool pledgets, a drop of eserine solution applied, and the speculum removed cautiously. The eye is kept bandaged up for several days, sal-alembroth wool and gauze being used for the dressing. It should be removed daily, the lids bathed, and the dressing reapplied.

Complications of the operation, &c.—Owing to the anterior chamber being generally very shallow in acute glaucoma, it requires considerable skill to make the section behind the sclero-corneal junction and yet in front of the iris. On account of the tension a sudden spurt of aqueous, as soon as the section is made, is very liable to occur and to increase the risk of wound of the lens.

The dilated blood-vessels of the conjunctiva bleed readily during the section, and it occasionally happens that the sudden relief of tension is followed by profuse intra-ocular hæmorrhage, destroying vision and rendering subsequent enucleation necessary.

4. NEEDLING OPERATIONS FOR SOFT CATARACT

These are only suitable in early life, and are used chiefly for lamellar or congenital cataract. It may be necessary to give an anæsthetic, though cocaine will often suffice. The pupil should be fully dilated with atropine before the operation, and its use continued during the whole process of swelling-up and absorption of the lens-matter, this often taking many weeks. The lids being either held open or kept so by a speculum, a cataract-needle is introduced through the cornea near its margin and directed towards the centre of the pupil; its point is then turned backwards and made to tear the capsule and front of the lens. The needle is withdrawn, taking care not to touch the iris. It is well to use iced-water dressing for forty-eight hours, and to keep the patient in a darkened room (Nettleship). The lens-matter if exposed to the action of the aqueous humour, swells and projects into the anterior chamber, and is slowly absorbed. After a month or two, if no irritation or congestion is present, the needling may be repeated, and sometimes three or four operations are required.

Some operators prefer to hasten the process by needling freely at first, and, when the lens has become swollen and softened, letting it out through a small incision made with a narrow keratome, either by the curette and slight finger-pressure, if required, or by the use of a special suction instrument. Of course, after the cataract has been removed, the patient will require convex lenses to read with—about 10D to 12D for distant vision, about 16D to 18D for near vision.

5. EXTRACTION OF HARD CATARACT

The operation generally performed is what is known as a modified Graefe's extraction, the narrow knife named after that surgeon being used, and the section lying chiefly at the sclero-corneal junction.

Frequently a small upward iridectomy is performed some weeks or months before the removal of the cataract, and this proceeding, though it involves two operations, appears to increase the chance of the result proving satisfactory. If preliminary iridectomy is not done the proceeding is as follows: the eye being under the full influence of cocaine, and a boracic solution having been used to render the conjunctiva aseptic, the speculum also being in place, the operator fixes the eye as already described (*see* Iridectomy), and introduces the knife with its point directed towards the entre of the pupil, at or just behind the sclero-corneal junction. As soon s the blade is well in front of the iris the handle is depressed and the point arried across to emerge at a point corresponding to the one of entrance. he puncture and counter-puncture are so placed as to include between them bout two-fifths of the corneal circumference. The incision is then comleted by to-and-fro action of the knife, the edge of which is turned somehat forwards as it cuts through. Care should be taken not to press upon ie globe with the fixation-forceps, which simply effect gentle downward action. The iris-forceps is now introduced, the upper part of the iris rawn out and removed by a single cut of the scissors (the amount removed eing much smaller than is necessary for glaucoma). The cystitome is then assed into the anterior chamber, its point turned towards the lens and iade to tear through the capsule transversely (some operators add a vertical ivision of the capsule). By steady pressure with a curette, placed at the wer border of the cornea, the lens is now made to tilt forwards and to resent in the wound. The pressure is relaxed as soon as the greatest iameter of the lens has emerged, for fear of escape of vitreous. Frequently me manipulation with the finger through the lower lid is finally needed, coax out bits of lens-cortex which have remained.

The margins of the iris should now be depressed away from the wound they tend to protrude, and after it has been ascertained that the edges of ie wound lie in good apposition, the upper lid should be cautiously lifted er it and the closed eyes bandaged up with a four-tailed bandage.

It should be noted that before bringing pressure on the globe to extract ie lens the speculum should be relaxed or held forwards by the assistant.

After-treatment.—The patient is usually kept in a darkened room for out a week, the bandage changed and the lids bathed once or twice daily, id atropine used if frontal pain, &c., suggests the onset of iritis. Leeches the temple are also advised by some surgeons in the latter case. At the id of a fortnight, if all goes well, the patient may go about with protective ggles, and a few weeks later be tested for glasses.

Complications, &c.—Escape of vitreous is much to be dreaded if the cision be made too far back, in myopic eyes, &c. Should it occur before e lens projects the scoop should at once be introduced and the lens drawn it with it. The operation should in any case be brought to a speedy ose and the eye bandaged up.

In a certain small proportion of cataract cases the eye suppurates, or comes the seat of severe iritis. In a great many it is necessary to perform bsequent needling operations for the removal of opaque capsule.

CHAPTER X

INJURIES AND DISEASES OF THE FACE AND NOSE

MALFORMATIONS

Malformations of the face result from imperfect development or incomplete fusion of the median (fronto-nasal) maxillary or mandibular processes. They may affect the soft parts only, the bones being properly formed beneath, or the soft parts and the bones as well.

Hare-lip, which is by far the most common, is due to the failure of union between the margins of the maxillary and fronto-nasal lobes. It may occur on one side only (and then nearly always upon the left) or on both, and there may be merely a notch on the red margin of the lip, or a deep wedge-shaped defect, or a complete division extending into the nose. In this last case there is always at the same time a defect in the alveolar border, usually between the middle and lateral incisor teeth; and in many instances the palate is imperfectly developed as well.

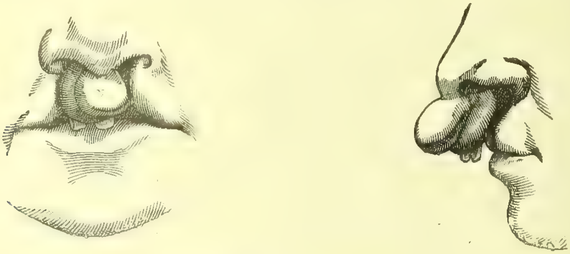

Fig. 309.—Double hare-lip.

When the hare-lip is double and extends into the bone on both sides (a condition always associated with cleft palate) the extremity of the fronto-nasal process, carrying the two premaxillary bones, with the germs of most of the incisor teeth, is completely detached from the maxillæ and often from the vomer, so that it remains suspended from the column, and sometimes from the tip of the nose (fig. 309).

In comparison with this, other malformations on the exterior of the face are very rare. The maxillary sometimes fails to unite with the mandibular process, so that the mouth is prolonged upwards towards the ear (macrostoma); the lachrymal cleft may remain open, and a median fissure may make its appearance in the fronto-nasal process, between the two premaxillary bones. Supernumerary auricles are not uncommon, and are often associated with macrostoma. Similar growths of smaller size may be met with in the neck at the sites of the second and third branchial clefts.

Treatment.—The operation for hare-lip has been performed within a few hours of birth. As a rule it is advisable to wait until the child is a onth or six weeks old, and in complicated cases later still. Chloroform hould be used as the anæsthetic, and the assistant who fixes the head hould at the same time compress the facial arteries where they pass over he lower jaw. Sometimes it is advisable to secure the coronaries as well

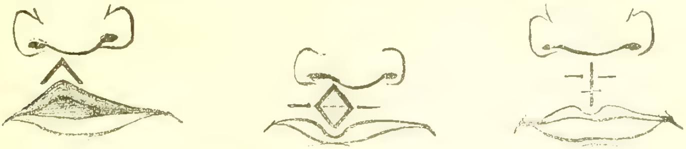

FIG. 310.—Operation for single hare-lip when the fissure does not extend into the nostril.

ither with the finger and thumb, after the lip has been detached, or with pair of forceps, the blades of which are guarded with rubber. It is conenient to wrap the child round in a towel so as to prevent any movement if he anæsthesia is not sufficiently long.

The lips are first thoroughly freed by dividing the folds of mucous embrane, keeping the knife close to the bone. Then the edges are pared, he opposing red margins removed, and the raw surfaces brought together such a way as to maintain the border line of the lip as accurately as ossible.

Where the cleft is incomplete, Nélaton's incision is the best. The angle f each flap is grasped in turn with a pair of forceps and a Λ-shaped incision ade above the cleft, the length of the two sides depending upon the degree f deformity. A silk ligature is then passed through the incision and drawn ownwards; this inverts the flap and brings together the opposing surfaces, hich may be at once secured with sutures. A slight projection is left on e border of the lip, but it soon disappears. The vertical cicatrix, after the peration for hare-lip, has a strong tendency to contract, and if the red line accurately adjusted in the infant there is almost sure to be a notch in e adult. This operation is sometimes performed at puberty to rectify the efect left by a previous one.

The same incisions are made when the cleft is complete, if the two sides e fairly equal. The apex, of course, is wanting, and the two are separate ove as well as below. The flaps reflected from the margins are turned wn in the same way, but the whole length is not required and should t be preserved. This is sometimes known as Malgaigne's operation.

If the two borders are very unequal—one, for example, short and vertical, e other long and sloping—a further modification is advisable. The flap on

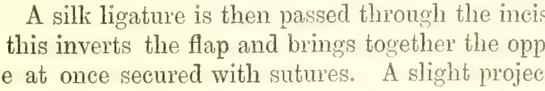

FIG. 311.—Operation for single hare-lip when the sides of the fissure are unequal.

e sloping side is completely cut away; that on the vertical, on the other and, remains attached at its lower extremity, and is turned down so that lies under the cut surface of the other. For this to succeed, the lips must e thoroughly freed and the flaps thick and substantial.

Double hare-lip is more serious. If the intermaxillary bones are in their proper situation and the median portion is well developed, the difficulty is not very great. The sides and lower border of the central projection must be freely pared, the whole of the red border being removed; and two flaps must be fashioned, one on each side from the lateral portions, so that they may meet each other in the middle line, below the median. To secure a good result, both sides must be done at the same time.

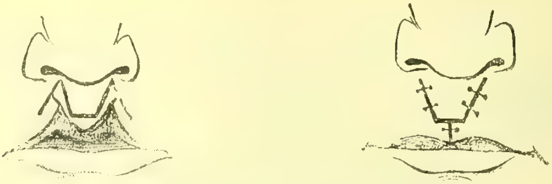

Fig. 312.—Operation for double hare-lip.

The intermaxillary bones, even when they project as far forwards as the tip of the nose, should always be preserved if they possibly can. It is true the incisor teeth rarely or never develop properly, and that it adds greatly to the difficulty of securing primary union, but if this part is removed, the upper lip sinks inwards so as to produce a most unpleasing effect. In many cases it can be pressed back. If this cannot be done, or if it tends to come forward again, the septum may be broken by grasping it with the blades of a pair of forceps (guarded with rubber) and twisting it. If this does not succeed, a triangular portion of the cartilage behind it may be excised, a longitudinal incision being made along its lower border, and the soft parts carefully separated on either side, so as to preserve the blood-supply intact. In any case, it is advisable to secure it in its proper position by means of a chromic gut suture passed through the maxilla, as the least pressure forwards prevents the soft parts uniting; and sometimes this may be done with advantage a week or two before the lip is touched. There are, however, a few cases in which the defect is so great, involving the nose as well, that the bones must be sacrificed (not the periosteum, which can be left intact), and the soft parts used as a support for the tip. The cleft in this case is closed by the lateral flaps alone.

Silk-worm gut should be used for the sutures, one of which should be passed through the margin; another, if possible, from the mucous surface the rest, as many as may be required, must be inserted through the skin Hare-lip pins are to be avoided; the coronary artery can be secured, an accurate adjustment maintained as well with ordinary sutures, without th risk of leaving such scars. The wound may either be left exposed to the ai for a minute or two that the discharge may dry upon it, or dusted lightl with iodoform. Collodion is liable to cause great smarting. If the lip i properly separated from the bone beneath, there is very little tension on th parts. To prevent the muscles interfering with union, two pieces of strapping, cut in the shape of a banjo, should be applied, one to each cheek, an then, while the tissues are rolled up together under the nose by the pressu of the finger and thumb, the tails should be secured across the front, slippin one through a slit in the other. The same precaution should be adopte when the wound is dressed, the head of the infant being held between th knees, while the nurse, seated in front, supports the body and holds th mbs. Many kinds of trusses and supports have been devised to hold e cheeks together, but none of them are thoroughly satisfactory, and I ave seen children with great scars upon their cheeks caused by sloughing.

The sutures are removed upon the second day ; deep ones passed through e bone may be left longer, and if of catgut need not be interfered with. ven if primary union fails, the gap may be bridged across by granulations, ut the cicatrix is very conspicuous. The child must, of course, be kept uiet ; it may be allowed to take the breast as usual, but should not retain a ubber teat constantly in its mouth, and care must be taken to keep the ostrils clear with a camel's-hair brush and vaseline.

INJURIES AND DISEASES OF THE FACE

Wounds

Owing to the abundant supply of blood, wounds of the face heal very apidly. In burns, however, and in gunshot injuries in which there is much ss of tissue, great care is required to prevent deformity ; the lower lip, for xample, may be drawn down to the neck, or the lower eye-lid permanently xed in a position of ectropion. Even when they are badly bruised the dges should always be brought accurately together and fastened by sutures : ine silver wire or silk-worm gut if the depth is not great ; hare-lip pins if, or instance, the lip is divided through into the mouth. It is essential to ring the scar into such a position that it will have the least effect upon he eye-lids and the mouth. A double set of sutures is sometimes advantageous, one through the mucous and the other through the cutaneous surface ; nd the latter may be subcuticular, *i.e.* carried through the corium from side o side without appearing upon the surface. In this case fine catgut must f course be used. Bleeding generally stops of itself, or as soon as the surfaces are brought into apposition ; but the facial artery may require twisting r tying. Sutures should be removed as early as possible, and the edges of he wound supported by pressure, so as to avoid scarring. Many instances re on record of large portions of the nose having united again after being ompletely detached.

Fractures

f the bones of the face are dealt with elsewhere. They are very frequently ompound and comminuted ; but extensive necrosis is unusual, and the prognosis, so far as life is concerned, is very good, unless the base of the skull (the roof of the nose, for example) is involved. Accurate apposition, however, so as to avoid deformity, is often a matter of great difficulty.

Foreign Bodies in the Nose

Pebbles, dried peas, pieces of slate-pencil and the like, are often pushed up the nose by children, and frequently, before the case is seen, are driven out of sight by ill-advised attempts at removal. With a proper light there is generally but little difficulty in laying hold of them from the front with polypus-forceps : but in many cases an anæsthetic is advisable, as it may be necessary either to push them back into the pharynx or to pass the fingers round the soft palate into the posterior nares. In the case of adults a recurrent stream of warm water may be used, and a sufficient degree of anæsthesia obtained by brushing the surface over with a 5 per cent. solution of cocaine. It must always be remembered that a pointed foreign body, such as a sharp piece of stick, is very easily driven through the cribriform plate.

Division of the Parotid Duct

is liable to be followed by salivary fistula, the opening of the cutaneous surface persisting, and the whole or greater part of the secretion pouring on to the skin, and giving rise to great discomfort and annoyance. To avoid this, the wound, if it does not already extend into the mouth, should be completed, and a catgut suture passed through the mucous membrane of the cheek and the adjacent wall of the duct on either side and knotted on the oral surface. The edges of the wound in the skin must then be brought together accurately, and rendered as secure as possible with collodion. Even if union does not take place at the first, the opening has a strong tendency to close, if only the saliva can find its way into the mouth.

Inflammatory Affections of the Face

Eczema is very common in children who suffer from disordered digestion, or who are recovering from any severe illness. It generally takes the form of impetigo, isolated patches or groups of vesicles with but little redness around, quickly becoming pustular, and forming thick light yellow crusts. When once it has developed it tends to appear wherever there is the least irritation, and it is often associated with blepharitis and phlyctenular conjunctivitis and followed by enlargement of lymphatic glands. In adults, it is rarely serious unless it assumes the form of *sycosis* or *mentagra—i.e.* when it attacks the cheeks or the chin, and causes the formation of a pustule around the root of every hair. Under these circumstances it may be very obstinate, returning again and again, and finally, when it does get well, leaving bald patches in the beard and whiskers. The treatment consists in removing the scabs or crusts, wherever they occur, with vaseline or boracic fomentations, and then either applying a mild astringent ointment, such as dilute nitrate of mercury, or trying to dry up the secreting surface by painting over it a thick lotion of calamine, zinc oxide, and lime water Careful attention must be paid to the diet and to the condition of the bowels especially in the case of children.

Tinea circinata is frequently met with upon the face in children, and i often associated with eczema and impetigo. When it occurs in adults an involves the hairy parts of the face, it gives rise to a form of sycosis, which except for the broken hairs and the presence of the fungus, is indistinguishable from that already described.

Herpes.—Two forms of this are common upon the face, herpes labiali and frontalis. In external appearance they resemble each other to a certai extent, but in their pathology they are entirely distinct.

The former occurs round the lips and mouth, sometimes spreading on t the nose and cheeks. Its first appearance is as a red œdematous patch c skin, upon which a number of small vesicles develop. In twenty-four hou these break, dry up and form scabs which drop off of themselves in two or three days, without leaving more than a slightly reddened macula. It attends rigors and catarrhal attacks of all kinds, but what the connection may be is not known. It may be present with a simple cold in the head, and in pyæmia a fresh crop may form with every rigor.

Herpes frontalis, on the other hand, like herpes zoster, always occurs in the distribution of a nerve, one or all of the branches of the ophthalmic division of the fifth. It may be preceded, attended, or followed by intense neuralgia; it is not unfrequently accompanied by inflammation of the conjunctiva, the cornea, and even of the iris; and when the scabs fall off it leaves cicatrices. It is supposed to depend upon some irritative lesion either of the Gasserian ganglion or of the division of the nerve beyond this, but the evidence is of the same character as that upon which the nervous theory of herpes zoster rests. There is no doubt that they are both more liable to occur in patients who are taking arsenic.

Acne.—The various forms of this have been described already; they are all common upon the face: acne punctata, for example, upon the forehead; the single suppurative variety round the nose and mouth; acne varioliformis on the sides and along the cheeks in front of the ears; and acne rosacea upon the nose. The last mentioned is especially associated with a dilated condition of the capillaries, and passes by imperceptible gradations into what has been termed *lipoma nasi*—a general hypertrophy of the skin, subcutaneous tissue, and sebaceous follicles about the tip of the nose, so that in extreme cases it is covered with irregular, pendulous, bluish-red masses (fig. 318). This condition is rarely met with before middle age, and is greatly aggravated, if not caused, by persistent indigestion, chronic alcoholism, and long-continued exposure to cold and wet. The treatment of acne has been described already; lipoma should be excised, taking care not to injure the cartilages and leaving sufficient skin to form flaps.

Facial carbuncle.—A peculiar form of carbuncle, caused probably by direct inoculation from some foul and putrid source, is occasionally met with upon the lip. It differs from the ordinary variety in the age of the patient (most of those I have seen have been in young men who were apparently in good health) and in the fact that numerous small abscesses are usually present rather than one single extensive slough. Probably this may be accounted for by the radial direction of the connective-tissue fibres in this part. The ordinary form may occur upon other parts of the face, as on the neck and back, in older people whose health is broken down. The subcutaneous induration is often of immense size, forming a hard, brawny swelling which extends all over the cheek and even down on to the neck. Sometimes this is preceded by a pustule (especially in inoculation cases) and frequently is accompanied by the formation of vesicles, so that in spite of the intense pain there is a superficial resemblance to true anthrax; the bacilli of this disease, however, are never present. In a severe case the constitutional symptoms are typhoid from the commencement, but in many of the milder inoculation ones the patient is but little inconvenienced.

Facial carbuncle is always serious, owing to the risk of meningitis and pyæmia. This arises entirely from the anatomical relations of the part, the free communication between the infraorbital and ophthalmic veins and the venous sinuses of the cranium on the one hand, and between the facial and jugular on the other; it is not the result of any specific quality.

Septic embolism of the lungs is found in a very large proportion of fatal cases.

The treatment consists in free incision. In the labial form, for example, the patient should be anæsthetised, and the whole swelling cut across with a sharp-pointed bistoury, introduced into the red margin, with the surface of the blade parallel to the skin. Afterwards the sloughs must be scraped out, and the resulting cavities and the abscesses that are opened thoroughly sponged with a 20 per cent. solution of carbolic acid. Usually this stays the progress of the inflammation at once, but the patient often must pass through a long and trying illness before convalescence is complete.

Anthrax.—True malignant pustule, due to the inoculation of the bacillus anthracis, is occasionally met with upon the face; but, except that its course is often exceedingly rapid, it does not differ, in any material respect, from the same disease in other parts of the body.

Cancrum oris, noma, or gangrenous stomatitis.—A peculiar form of inflammation, affecting the tissues of the cheek and rapidly running on to gangrene, sometimes occurs in poor half-starved children, during convalescence from specific fevers, especially measles and scarlatina. Its course and general characteristics are so uniform that it has been supposed by many to result from the action of a specific germ; but, in spite of the fact that cases of this kind frequently occur together (I have seen three from the same house, inhabited, it is true, by many families), it is very doubtful if there is anything of the kind. It seems much more probable that it is akin to phagedæna, caused by the ordinary organisms of suppuration acting under specially favourable conditions, and that when several cases of it are met with at the same time their occurrence is the result of the close similarity in the circumstances of life.

Sometimes it begins on the mucous surface, a sloughing ulcer forming near the orifice of Steno's duct (it has been suggested that the administration of mercury favours its occurrence), more often in the substance of the cheek itself. In either case the first external sign is an ill-defined but exceedingly hard patch, usually in the centre; the skin over it is dusky, glazed, and œdematous; the mucous membrane may be raised and livid, or already covered with an ashy-grey slough; there is little or no pain unless it is handled roughly, and the child scarcely pays any attention to it. Then a bulla rises in the middle, bursts and leaves a patch of black gangrene, which steadily increases in size, preceded by a narrow dusky rim, until the whole of the cheek is a coal-black slough, the lips destroyed, the side of the nose eaten away, and the jaws beneath exposed without even a covering of periosteum. The destruction on the inner surface of the cheek is even wider than that on the outer. I have seen it develop on the second side while the first was still in progress, until the whole of the face was destroyed, with the exception of the nose and a small median portion of the two lips.

A similar affection has been described, affecting the external organs of generation in female children living under the same conditions, but it is much more rare.

The constitutional disturbance throughout is strangely slight. The child often does not notice it, but plays with its toys, eats and sleeps as if it were absolutely unconcerned; then it either suddenly collapses or is attacked by septic pneumonia.

The only treatment of any avail is the actual cautery: the whole of the affected part must be deliberately excised. If the skin is not yet involved (such cases are rarely seen in time) it must be done from the interior, but nearly always there is already a blackened slough. The prognosis, so far as life is concerned, is very bad: recovery may, however, take place even when the jaws have been involved, leaving the most frightful deformity.

Erysipelas of the face does not require special mention. It is dangerous from the risk of its spreading to the meninges (though this is not so common as when the scalp is involved), and to the throat, causing erysipelatous laryngitis. The swelling when it spreads into the eye-lids is often enormous, and may require relief by puncture; on the nose and ears, on the other hand, it is very slight, but intensely painful. Repeated attacks lead, at length, to a very disfiguring degree of solid œdema.

Lupus.—The face is the favourite locality for all forms of lupus. The common variety, that which develops in young, fair-complexioned, and perhaps scrofulous subjects, and is characterised by the presence of little semi-translucent tubercles, which break and leave superficial sores, is especially frequent round the alæ of the nose and on the lips and cheeks. Sometimes it causes very serious deformity, destroying the cartilages, leaving the apertures of the nostrils widely open upon the face, and spreading into the gums and palate. It may be known by the age at which it occurs; its chronic persistent course, the characteristic tubercles and the thin red cicatrices, always on the point of breaking down. Erythematous or butterfly lupus, in which the amount of new growth is very much less, is more rare; and rarer still is an eczematous variety, often taken for eczema, but differing from it in the presence of a certain though small amount of lupus tissue, and in the fact that it leaves a scar.

Syphilis.—All forms of syphilitic eruption are common upon the face. Primary chancres are often met with on the lips, and may occur upon the eye-lids and other parts. They are easily recognised by the peculiar character of the induration, and are distinguished from epithelioma by the aspect of their base (which is not covered with epithelial débris), by the rapidity with which the sore develops and the quickness with which the glands become involved. It rarely happens that a hard chancre has lasted a fortnight before some evidence of these can be found, while an epithelioma, unless it has been irritated, rarely produces any effect under three or four months. Age is not so sure a test. Hunterian chancres may occur at any time of life, and I have seen a typical epithelioma of the lip in a man only thirty years of age. Sex, however, is sometimes of help, as epithelioma is very rare in women.

Secondary eruptions rarely fail. Roseola is the most common, especially on the forehead, under the roots of the hair, and in parts that are irritated by shaving. Alopecia may occur, although it is not so frequent as upon the scalp. The most serious is a form of phagedæna, which, from a superficial resemblance it possesses, has been called syphilitic lupus. It attacks the alæ of the nose, and causes greater destruction in three days than lupus in as many months. Very often it is associated with rupia, and occasionally, especially when it occurs in the later periods of the disease, with what used to be called *hypertrophic lupus*, an enormous purplish-red enlargement of the lower half of the nose. The only treatment is the acid nitrate of mercury as soon as there is the least indication of its appearance. The cicatrix is firm and dead-white, without the least tendency to break down, and utterly unlike, therefore, that which follows tubercular lupus.

Tertiary symptoms are almost as frequent. Papular serpiginous eruptions are common upon the skin around the mouth and nose, and rhagades and painful fissures frequently occur at the angles. The former subside under treatment without a permanent mark; the latter leave dead-white linear radiating cicatrices. In the later stages, when the amount of exudation is greater, these papules are succeeded by scaly dusky-red tubercles, still arranged in the same way. At first these may also be absorbed, although they are liable to leave behind atrophied patches of skin where the papillæ have been destroyed; after a time, however, especially if the health begins to fail, they increase in size, and then they usually break down and suppurate. Later still, and in intractable cases, the amount of exudation may be so great that the tissues perish and sloughing gummata form. Sometimes it is only the skin that is affected; more often there is a sodden mass in the subcutaneous tissue; and occasionally the bones are exposed and huge sequestra similar to those met with upon the forehead slowly exfoliate. Finally, in a few very rare instances, phagedænic gangrene sets in and rapidly proves fatal from septicæmia or septic pneumonia.

Similar affections occur in the hereditary form, and when no evidence can be obtained from the condition of the teeth or the cornea or the sunken bridge of the nose, it is often enough to mark the dead-white pits that surround the mouth and the linear radiating cicatrices that spread from the angles and the nose. A median cicatrix in the lower lip is of no significance in this respect.

Leprosy.—The earlier manifestations of this disease are occasionally met with upon the face in the shape of dusky erythematous patches, slightly scaly, and sometimes symmetrical. As they increase in size the centre becomes anæsthetic and grows paler and paler until it is dead-white. Tubercular masses, leading to great disfigurement, are common in the later period.

Rhinoscleroma is a very rare disease, which is only known to occur upon the nose and upper lip. It first appears as a hard nodule, covered over with reddish skin, growing usually from the columna. As time passes it slowly increases in size until it forms a dense bossy mass, as hard as a fibroma, which blocks up the nostrils, extends along the inferior meatus, involves the palate, and causes an immense projection of the upper lip. By-and-by it begins to ulcerate, but the process is always slow. It may be excised, but, unless it is removed very thoroughly, the wound heals up and the growth begins again. The lymphatic glands never appear to be involved. Histologically it resembles other granulation-tissue growths, composed of ordinary round cells with a few of larger size. Sometimes it appears as if the epidermis were inclined to grow downwards as in epithelioma. Payne and others have described short ovoid bacilli in connection with it, but its proper relationship is still uncertain.

Tumours of the Face

Dermoid and *sebaceous cysts* are of common occurrence; *meibomian cysts*, which are developed in the eye-lids, and *lipoma nasi* (fig. 313) have been described elsewhere. The various forms of *hairy moles* and of *nævi* which are frequently met with, require very careful treatment, for fear of leaving a worse deformity. The former, if small, may be excised; the hair-sheaths in the larger ones are best destroyed by electrolysis, but the method is very tedious. The same may be said of nævi; subcutaneous ones can be dissected out, leaving a fine linear cicatrix, which, if carefully planned, is almost invisible in a few years' time; cutaneous ones, on the other hand, especially those of any extent and in the region of the eye-lids, should be very carefully dealt with. The most satisfactory method is the application of the constant current, using only the positive pole (the negative applied to the skin elsewhere), but it requires a great deal of patience.

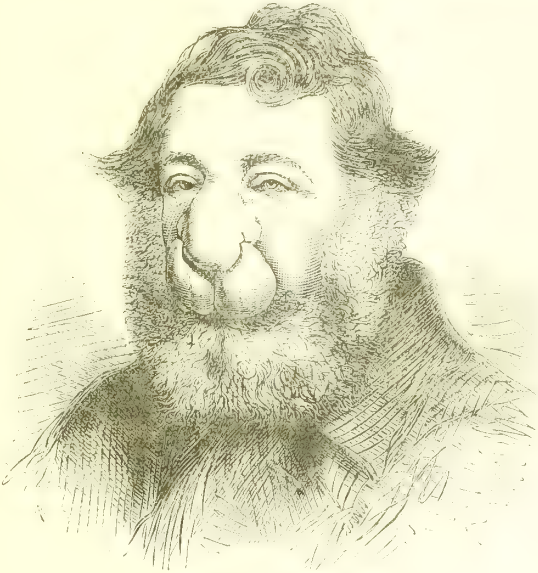

FIG 313.—Lipoma nasi.

Molluscum contagiosum is very common in children and can be recognised by the clear semi-translucent appearance of the little masses, even when there is no depression upon them. The other variety (*fibrosum*) is rarer, the face often remaining free when the body is almost covered.

Rodent ulcer.—This is a variety of epithelioma (beginning in connection with the hair-sheaths) which is rarely met with under fifty years of age and in other parts of the body than the forehead, face, and scalp. It is exceedingly slow in its progress, and does not involve the lymphatic glands; but if left to itself or incompletely removed, it tends slowly to infiltrate and eat into all the structures near, until, if it is growing at the corner of the eye (its favourite seat), it may destroy the eye-ball and expose the brain. It usually begins as a reddish-brown elevation of the skin, like a wart. By degrees this becomes scaly, and then, after the surface has come away a few times, a small ulcer forms: the edges irregular, sinuous, a little raised and already hardened; the base depressed, pale, devoid of granulations, and secreting a thin serous fluid. The longer it lasts the wider and deeper it spreads; but, usually, it is several years before it attains any size. Throughout, unless it is irritated and inflamed, it retain the same indolent character, but I have known it spread much more rapidly after ineffectual attempts at removal by means of caustics and poultices.

The only treatment is complete removal, the earlier the better.

Epithelioma.—Squamous-celled carcinoma may occur in the same region of the face as rodent, or upon the nose, but the favourite locality is the lower lip, on the red portion, or at the junction of this with the skin. On the upper it is exceedingly rare. There is no doubt that it is often caused by the persistent irritation of a clay pipe, the soft epidermis of the lip adhering to the porous surface of the clay, so that when this is removed, it brings away with it the protecting layer; and it is said to be nearly as common among the women of the lower classes in Ireland as among men; but there is no doubt that it does occur also in those who have never smoked.

It may commence in various ways: either as a crack or fissure which refuses to heal and grows harder and harder, or as a raised papillomatous surface covered with unaltered epithelium. At first its progress is slow; and, particularly in old people, it may remain concealed beneath a scab for months without apparently undergoing any change. By degrees, however, it assumes the type of an epitheliomatous ulcer, with a ragged, irregular, sloughing base, and raised, everted, and hardened edges. Sometimes, when it is irritated (especially by caustics) it fungates and grows with great rapidity. If it is left, the glands beneath the jaw become affected, the disease spreads into the surrounding tissues, the ulceration extends wider and wider and becomes intensely painful, and the patient, after a time, begins to sink very rapidly, worn out by the pain, inability to take food, and repeated hæmorrhages, and half-poisoned by the passage of septic débris into the lungs and the alimentary canal. The glands often attain a very large size and fungate through the skin as well as into the mouth, bleeding profusely at the slightest touch; but wider secondary deposits are rather the exception.

Excision should be performed as soon as possible, the whole affected portion being removed by a V-shaped incision. As patients usually apply for treatment earlier than in other forms of carcinoma, the results are fairly good; but care must be taken to keep clear of the growth on either side, as there is a distinct tendency for it to spread laterally under the epithelium. The assistant should grasp the lip with his finger and thumb so as to compress the coronary arteries. Hare-lip pins, passed from the cutaneous almost to the mucous surface, are used to bring the wound together, silk being twisted over them in a figure-of-eight, but they must not be left more than forty-eight hours. One or two other sutures may be inserted with advantage and left a day or two longer.

When the glands are involved, the same operation should be performed, and the secondary deposits excised, if there is a chance of removing the whole of the disease. It is true there is scarcely a hope of curing the patient; but, at the risk of what is not a very severe operation, there is a possibility of giving him material relief, and of freeing him from a foul and offensive ulcer, involving more or less the whole of his mouth, poisoning him, and rendering existence almost intolerable.

Other forms of malignant growth (independently of those spreading from the bones and subjacent structures) are rare. I have met with a pigmented form of epithelioma upon the cheek, and with one or two instances in which sarcomatous growths apparently originated in the subcutaneous tissue; but the diagnosis and treatment present no special feature of interest.

The diagnosis between lupoid, syphilitic, rodent, and epitheliomatous ulcers upon the face, occasionally presents a little difficulty.

Age.—Lupus occurs chiefly in young adults; syphilis in adult life; epithelioma and rodent not until much later.

Course.—Lupus is very chronic; probably it has already lasted months or even years. Syphilis is more acute, often it is only a question of days; although I have known patches of a syphilitic tubercular eruption persist for months without much change. Epithelioma is fairly rapid, especially if it is irritated, making more progress in a month than rodent in a year.

Tendency to heal.—This is nearly always present in lupus, and the cicatrix is red, and so thin that it is always breaking down again. If it occurs in syphilis, the scar-tissue is dense and white. It is not present in rodent or epithelioma, except as a result of operation.

Origin.—Groups of semi-translucent lupus tubercles round the margin are distinctive; those of syphilis are never really like them, except in shape. A single hard nodule may precede the others.

Edges.—The outline of lupus is usually irregular and the margins soft. Syphilitic eruptions have a tendency to assume a crescentic form. Rodent is generally circular, with hard, rounded, rolled-over margins; while in epithelioma the induration always extends a considerable distance.

Base.—In lupus the surface is concealed beneath scabs or covered with pale, flabby granulations. A syphilitic sore, so long as it is spreading, is foul and sloughing; rodent is smooth and glossy on the surface; while the floor of an epitheliomatous sore is hard, nodular, covered with epithelial débris, and secretes a foul, purulent discharge.

DISEASES OF THE NOSE

MALFORMATIONS AND DEFORMITIES

Congenital malformations are rare; deformities, on the other hand, resulting from injury, lupus, or syphilis are very common.

Deviations of the septum should be straightened at once by means of forceps; but the tendency to return, even in the case of accidents, is so great that either the process has to be repeated again and again, or a truss or mask, devised for each special case, must be worn at night.

Extensive destruction of the soft parts can sometimes be remedied by means of a plastic operation; but, in cases in which it is due to disease, this should never be attempted until the stump is perfectly sound. The two best known methods are the Indian, and that first carried out by Tagliacozza (the Italian).

In the former a flap of suitable shape is marked out upon the forehead, having its pedicle immediately over the root of the nose, or slightly to one side, so that it can be twisted down more easily. This is carefully dissected up (Langenbeck recommends that the periosteum should be brought away with it), adjusted in a bed prepared for it by cutting away the old scar-tissue around the margins of the orifice, and secured with sutures, hollow plugs being inserted into the nostril, so that it may retain its shape. To avoid the sinking inwards of the tip, Langenbeck reflected some of the bony margin of the nostril, fashioning a flap from each side, so that they should meet like the rafters of a roof in the middle; but when the nose has been destroyed by inflammation this proceeding is rarely practicable.

In the Italian method the skin is taken from the arm over the biceps. In the original plan the flap was raised by an incision down each side and left to granulate; then the upper end was separated; and after the skin, detached now on three sides, had begun to shrink, it was carefully fixed by sutures in the freshly cut margins of the defect. The arm is fixed with plaster bandages in a suitable position, and it must be retained like this without the slightest traction for at least eight days. The treatment has since been shortened by detaching the flap at an earlier date, but naturally with some risk.

Of these two methods there is no doubt the former is the better where it is practicable, in spite of the scar it leaves. In the latter the transplanted flap sinks into a shapeless mass. Neither, however, is really satisfactory, and it is probable that in most cases the deformity would be better concealed by an artificial nose, made from vulcanite or enamelled silver, and fastened on to a spectacle frame.

In cases in which one ala only is defective, Langenbeck's plan of reflecting a flap from the other on the opposite side (leaving it attached by a bridge upon the dorsum) tends to diminish, or at least equalise the deformity. There is, however, some difficulty in separating the skin from the cartilage without cutting or bruising it, owing to the very close connection that exists between the two.

EPISTAXIS

Hæmorrhage from the nose may be very serious, the blood pouring down the posterior nares as well as the anterior, and being swallowed, so that the patient is not aware of the amount that is lost. In most instances it is merely a symptom of some other trouble, sometimes a very grave one; but, for convenience of classification, the causes may be divided into general and local.

(*a*) *General.*—Some of these are congenital—hæmophilia, for example—and a curious tendency towards nose-bleeding, which is not uncommon in certain families, sometimes in both sexes, more often in the males alone, and only persists during certain years of life. Morbid conditions of the blood, as in scurvy, leukhæmia, purpura, acute specific fevers, &c.; and general affections of the circulation, such as are met with in connection with Bright's disease, cirrhosis of the liver, plethora and gout, are more common. In some instances epistaxis is said to be vicarious.

(*b*) *Local.*—All forms of injury, inflammation (whether specific or not), and new growths, may be attended by epistaxis. It rarely happens, however (except in the case of nasopharyngeal polypi, and occasionally as a result of injury), that the loss from these causes is of the same serious and persistent character as from the former. It may be smart for the time, but as there is no constitutional disorder, no serious affection of the blood or blood-vessels, it can usually be checked without difficulty.

Treatment.—Raising the corresponding arm above the head; compressing that side of the nose with the finger; cold-sponging of the face; applying cold to the nape of the neck, and other simple remedies should be tried first. If they do not succeed, the patient should lie down and an ice-bag be applied over the nose, but watch must be kept that the blood does not trickle down into the pharynx. All muscular effort, and especially blowing the nose, must be forbidden. Washing out the nose with ice-cold water, or with water tinged with perchloride of iron, is more effectual. The internal administration of such drugs as acetate of lead, gallic acid, and ergot, is of little use, though more may be said in favour of opium. Finally, if the hæmorrhage persists or returns again and again, the nostrils must be plugged.

There are two ways in which this may be accomplished. The best is with a thin dilatable rubber tube, which may with advantage have two bulbs upon it about an inch apart, for the better closing of the apertures. This must be passed by means of a long probe along the floor of the inferior meatus, until the farther of the two bulbs lies in the posterior nares; then distended to its utmost with air or water, and the contents prevented from escaping by clamping or tying the projecting end. It fits accurately into all the recesses, exerting an equable degree of pressure, and fills the cavity so closely that very little blood collects. At the end of twenty-four hours the contents may be allowed to escape, and the bag quietly withdrawn.

Where this is not at hand and cannot be improvised, Bellocq's sound, or, failing this, a gum-elastic catheter must be used. The sound is passed down the nostril; the end protruded, and caught in the mouth; it is then threaded with stout silk and withdrawn, leaving a double ligature passing along the inferior meatus, behind the soft palate and out through the mouth. Two plugs are then prepared, of compressed sponge or cotton-wool, about the size of the last phalanx of the thumb. One of these is tied tightly round the middle and fastened to the threads hanging from the mouth. The ends should not be cut off, but left, so that when the plug is carried on the tip of the finger to its proper site, the posterior nares, they may hang down in the pharynx. As soon as this is adjusted the other ends, projecting from the nostril in front, are drawn tight and knotted securely together over the other plug, which is placed between them in the anterior opening. At the end of twenty-four hours the string that hangs down the pharynx should be fished up, the knot that secures the anterior plug divided, and the two gently drawn away. If they are left longer they are very likely to cause ulceration; and, as the whole cavity of the nose is filled with blood

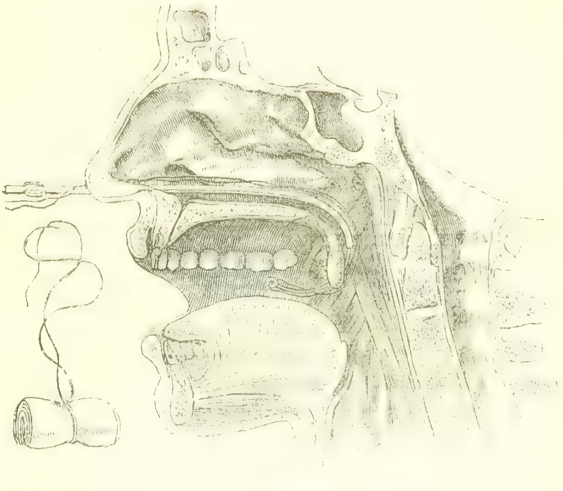

FIG. 311.—Bellocq's sound.

which soon decomposes, this may lead to very severe inflammation and necrosis, or even worse.

Inflammation of the Mucous Lining

Acute catarrhal inflammation is easily caused by exposure to cold or by irritating dust or vapours. The mucous membrane becomes swollen, there is a profuse watery discharge with sneezing (coryza), the respiration through the nose is obstructed, smell and taste are lost, and, if the lining of the frontal sinuses is affected, there is usually frontal headache with a certain amount of fever. In most people this subsides as soon as the irritant is removed, or yields at once to ordinary remedies, such as Dover's powder or a Turkish bath; but, occasionally, either because the tissues are peculiarly delicate and unable to regain their strength at once, or because of the persistence of some irritant, the inflammation continues, spreads over the adjacent mucous surface, and becomes chronic.

Chronic inflammation is either the result of frequent repetition, the congestion and exudation of one attack not having time to subside before they are made worse by another; or of some constitutional disorder such as tubercle, syphilis, or gout. In many cases it is associated with outgrowths from the mucous membrane (polypi and adenoid growths) caused by the persistent irritation.

Numerous varieties have been described, some well characterised. One, for example, is frequent in syphilis, especially the hereditary form, causing what is known as *snuffles*. Another, the *hypertrophic* variety, is almost as common in scrofulous subjects about puberty. The mucous membrane (chiefly that covering the inferior turbinate bone) is enormously thickened; the surface is red and granular, secreting a thick muco-purulent discharge; the nasal passages are blocked, the hypertrophied mucous membrane fills the posterior nares, and projects so far into the anterior that, in spite of the colour and rough appearance of the surface, it is often mistaken for a polypus; the wall of the pharynx becomes affected, the Eustachian tubes are closed, and the tone of the voice completely altered. In a third (*atrophic catarrh*), which may possibly be a further development of this, the change is exactly the opposite: the mucous membrane becomes atrophied, the glands disappear, and the nasal cavities are enlarged. With this is often associated a form of ozæna, due apparently to the decomposition of discharge retained in outlying dilatations or prevented from escaping by the crusts and scabs that form. In many instances, however, particularly when there is no specific irritant, no definite classification is possible; the mucous membrane simply becomes rough and granular, the layers beneath hard and fibrous, the glands enlarge, their secretion alters, the veins, and probably the lymphatics, become varicose, and the smooth, soft, natural surface is completely lost.

Treatment.—Syphilitic coryza quickly disappears under mercury; and, though the prospect is less hopeful, a very great deal of improvement can be effected in scrofulous cases by iron, cod-liver oil, and especially residence at the seaside. Local treatment, however, is usually required as well. Temporary relief, especially from the attacks of sneezing, which are often very painful, can be obtained by brushing the mucous membrane over with a 5 per cent. solution of cocaine. The spray or the nasal douche is more effectual for checking secretion and diminishing congestion. Tannic acid, sulphate or chloride of zinc, carbolic acid, tincture of eucalyptus, and many other astringents and antiseptics are recommended; the chief thing is the thoroughness of their application. If the spray is used, it must be directed up the posterior nares by means of a properly curved nozzle, as well as up the anterior; if the douche, the stream must be of full volume and allowed to flow back through both nostrils. Afterwards an astringent powder (tannic acid, for example, with subnitrate of bismuth, or alum and oxide of zinc) should be applied, but care must be taken not to make the inflammation worse by constant irritation.

In cases in which the hypertrophy is extreme, it may be necessary to reduce the swelling by caustics or by removing some of the redundant tissue. Nitric acid has been applied with benefit, and so has the actual cautery; and portions of the turbinate bones may easily be removed with forceps (this is often done in the case of polypi), but the most effectual method is the galvano-cautery, the loop of wire being adjusted over the projecting part and gradually tightened up; the margin of the septum and of the ala must be protected with an ivory speculum.

Inflammation of the Bones of the Nose,

leading to caries and necrosis, is usually the result of syphilis, hereditary or acquired; but it may be due to tubercle or glanders, to injury, the presence of foreign bodies, septic decomposition, mercury, and occasionally the fumes of bichromate of potash. The septum may be attacked, so that the bridge of the nose sinks in (although, in an adult, a great deal may be lost without any apparent alteration in shape), or the turbinate bones, or the roof, and in the latter case there is always the risk of meningitis. The symptoms are those of inflammation of the mucous membrane, but the discharge is always profuse and fœtid, the breath exceedingly foul, and nothing, so long as any dead bone is there, gives more than temporary relief. In many cases the diagnosis is clear at the first glance: either there is a perforation of the hard palate, or a probe introduced into the nasal cavity strikes the sequestrum at once; but sometimes, especially when it lies towards the upper and back part, detection is a matter of very great difficulty.

Treatment.—The dead bone must be removed as soon as it is loose, careful attention being paid at the same time to any constitutional taint that is present. In most cases it can be extracted, under an anæsthetic, through the anterior nares; sometimes it is easier to push it back into the pharynx (the two forefingers can usually be made to meet in the inferior meatus of the nose, the one introduced from the front, the other from behind, when the patient is anæsthetised), but the operator must be prepared for free, though not usually serious, hæmorrhage. Where, owing to the size of the fragment, this cannot be done, *Rouge's operation* may be performed, *i.e.* an incision made through the mucous membrane, where it is reflected from the under surface of the upper lip on to the gum; the cartilaginous septum detached from the anterior nasal spine, and, if necessary, from the maxillary crest; the alæ detached at the margins, and the upper lip with the nose lifted up and reflected on to the forehead. The nasal cavities are thoroughly opened up to view by this, the whole interior can be examined, and then the nose and lip replaced without a suture being required or a mark left.

If the dead bone, without being loose, is fairly accessible, as frequently happens in hereditary syphilis, it may be partially dissolved away by a sulphurous acid spray (which also helps to check the fœtor), and occasionally can be chipped off in little pieces with a fine chisel, but care must be taken that the instrument does not slip and penetrate the roof.

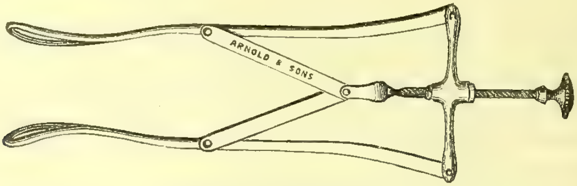

Fig. 315.—Nasal speculum.

Ozæna

By this is understood a persistent offensive discharge from the nose, caused either by necrosis (syphilitic, tubercular, or traumatic), or by the atrophic form of catarrhal inflammation. The smell, which is often not perceptible to the patient (differing in this respect from ozæna of the antrum) is infinitely more offensive than that of ordinary putrefaction. Possibly in necrosis cases this is due to the presence of dead bone (which it is well known possesses this property); in others, however, it must arise from some special kind of fermentation, for which there is every facility.

Opinions differ very greatly as to the relative proportion of cases in which dead bone is present. According to some, it is never wanting, although there may be great difficulty in finding it; sometimes it has not been discovered until Rouge's operation has been performed. Probably it is present in the majority, especially as there is very often evidence of syphilis; and certainly its absence should never be assumed until after the most thorough exploration.

Treatment.—Constitutional treatment is always needed; even when there is no necrosis, there is very frequently ulceration depending upon some constitutional taint such as syphilis or tubercle. Locally, the first thing is to reduce the fœtor as far as possible by means of the nasal douche, using Condy's fluid and very dilute carbolic acid at first, and, later, when the patient is more accustomed to it, chloride of zinc (one-eighth of a grain to the ounce), and corrosive sublimate (1 in 10,000). The chief difficulty is to make the lotion penetrate into the recesses, and this is hardly possible unless the bore of the tube is as large as the nostril will admit. In many cases, the spray and volatile antiseptics, such as iodine vapour, sulphurou acid and eucalyptus, are more effectual. As soon as this is to some exten overcome, the interior of the nose must be thoroughly examined both by sight and touch, from in front and behind. If any dead bone can be found it should be removed or chipped away so as to reduce the size of the offensiv surface; lupoid ulceration must be thoroughly scraped out, the bleedin being stopped with the actual cautery, and syphilitic sores touched with th acid nitrate of mercury.

If the disease is too extensive to be dealt with through the anterio nares, or if no cause can be found, and the ozæna still persists in spite o all that can be done, the interior must be further exposed by operation. Not only is the patient's presence almost intolerable to others, but his own life is seriously endangered by the constant inhalation of the poisonous odours. One or both alæ may be reflected without leaving any conspicuous mark if the line of incision is carried along the junction of the nose with the face, but in most cases Rouge's operation is preferable, as being more thorough and leaving no deformity.

Tumours of the Nasal Passages

The majority of tumours that grow in the interior of the nose tend to assume the polypoid shape. Some (adenomyxomata, the so-called mucous or gelatinous polypi) spring from the submucous tissue covering the turbinate bones, especially the middle, but occasionally the superior. Like the polypi that occur on other mucous membranes, they are essentially local hypertrophies, caused by constant irritation. Others, which are very much more rare, are formed of fibrous or fibro-sarcomatous tissue in varying proportions, and grow from the roof and occasionally the septum. These belong to the same order as the naso-pharyngeal polypi which are attached to the roof and other parts of the pharynx, and spread from them into the nose. In addition a few cases of papilloma and columnar epithelioma are recorded, but they do not require special mention.

Mucous polypi are composed chiefly of mucous or myxomatous tissue, covered over with columnar ciliated epithelium; but portions of glands (sometimes newly formed), cysts, and even widely dilated vessels, giving them an almost cavernous structure, are met with as well. They form soft, gelatinous, semi-translucent masses, pale pink or yellow in colour, projecting from the surface of the mucous membrane, and sometimes reaching far into the anterior and posterior nares. At first they are small and sessile, and in any advanced case numbers in this stage can be seen between the larger ones. Those that project towards the front can usually be seen at once (or if the patient expires forcibly), forming smooth, pedunculated masses very soft to the touch, and moving up and down with each breath. The deeper ones may require a speculum, and those that grow into the posterior nares can only be detected by introducing the finger round the margin of the soft palate. Occasionally, when one has been exposed to the air for any time, the surface becomes dry and rough, and then it may possibly be mistaken for an overgrowth of the mucous membrane over the inferior turbinate bone; otherwise it is difficult to see how such an error can arise.

Symptoms.—Chronic catarrh is always present. The breathing is obstructed (especially in wet weather, when the polypus swells up); the mouth is held open; the voice is altered and becomes nasal; the sense of smell and often that of hearing is lost; and nearly always there is constant frontal headache. In severe cases the shape of the nose may become altered by the internal pressure; the lachrymal duct obstructed; the septum displaced to one side; and the Eustachian tube blocked up. As a rule there is no bleeding and no offensive discharge, both of which symptoms are common in the case of malignant growths.

Treatment.—There are various ways of removing polypi. The simplest s to grasp the neck as high up as possible with a pair of slightly curved forceps having long serrated blades, and twist it round and round until it comes away (fig. 316). Mitchell Banks recommends that in bad cases the patient should be anæsthetised upon a sofa, and when fully insensible brought to the edge and placed so that the head hangs over. The surgeon then, kneeling on the floor, pulls out whole masses of the middle turbinate bone with the polypi upon them. If there is a very distinct pedicle, the ordinary wire écraseur may be employed, or the galvano-cautery, cocaine being used to allay the pain and prevent sneezing. Polypi that lie far back, in or near the posterior nares, can only be snared if the forefinger of the other hand is carried round the back of the soft palate to guide the loop. The bleeding is free, but stops at once upon the application of ice-cold water.

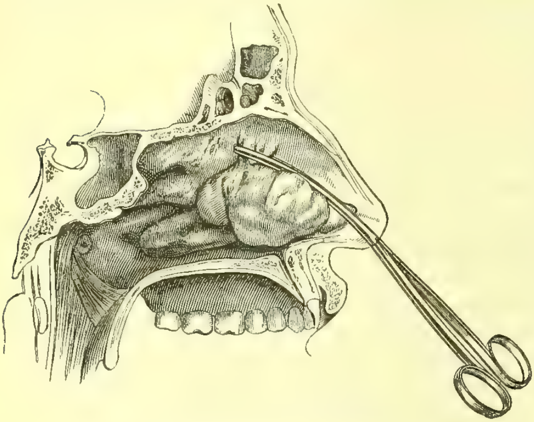

FIG. 316.—Method of grasping mucous polypi.

The chief difficulty is to make the removal thorough; and the operator should not be satisfied until the route between the two nares is completely freed. Even then many small growths must be left behind, and these, released from the pressure of the larger ones, and stimulated by the inflammation that follows the operation, are almost sure to spring up rapidly. To prevent this tannic acid or sulphate of zinc may be used as snuff, or the cavity may be washed out with boracic acid and alcohol, or with other astringents; but constant care is needed. In the worst cases it may be necessary to perform Rouge's operation.

Nasopharyngeal polypi.—These include all the varieties of fibroma, sarcoma, and fibro-sarcoma, which grow from the roof of the nose, the pharynx, or the pterygopalatine region. They are met with chiefly at puberty, and in boys, forming roundish lobulated masses covered over with a vascular mucous membrane. Some grow slowly and are firm and dense; others (which in all probability are round or spindle-celled sarcomata) are much softer and increase in size very rapidly. They are all exceedingly vascular (the walls of the vessels being very thin), so that they bleed with the least provocation and very profusely; and they spread in all directions, forming secondary attachments wherever they exert any pressure upon the mucous surface. The favourite locality is the basilar process, spreading forwards into the nose and down into the pharynx; but they grow sometimes from behind the superior maxilla (simulating a tumour of the antrum, except that the hard palate and the alveolar border are not depressed); from the ethmoid and sphenoid bones; and even from the septum. Occasionally enchondromata are met with.

The symptoms depend upon the direction the polypus takes. A fœtid, blood-stained discharge is nearly always present, as the surface of the growth breaks down and ulcerates; sometimes the epistaxis is so severe as to threaten life: the nostrils may be obstructed; the Eustachian tubes closed; deglutition may be impeded, and the most repulsive deformities (exophthalmos and rog-face) caused by the displacement of the features. Sometimes there is onstant headache with a tendency to coma and convulsions, suggesting that he meninges are implicated. It is said that nasopharyngeal growths some-imes atrophy, and they have been known to slough away of themselves, but s a rule progress is steadily from bad to worse, the profuse hæmorrhage in articular reducing the patient's strength.

The only treatment is free removal with thorough destruction or ablation f the surface from which it springs. Otherwise it is certain to return.

Small growths might probably be sometimes caught and twisted off, with roperly contrived forceps introduced through the nose, while the finger irects them from behind the soft palate. If a loop of wire can be adjusted ound the neck the bulk of the growth can be removed with the galvano-autery, or, if this is not at hand, with an ordinary wire écraseur; but in either ase the base must, in addition, be thoroughly seared. Hæmorrhage is sure o be profuse, and, particularly if the growth is a large one, springing from he base of the skull, there is very considerable risk of causing meningitis.

Electrolysis has succeeded and deserves a further trial. Both needles must be inserted and a current used as strong as the patient can bear, with the view of causing sloughing.

In most cases, however, a preliminary operation is required, in order to get sufficient space; the origin of the growth is not accessible without. Where this should be done depends upon what can be found out with regard to the position of the pedicle and the direction the growth has taken.

(*a*) If the polypus is situated low down it may be enough to divide the soft palate in the middle line (the flaps have been known to unite together again of themselves without a subsequent operation); or, if this is not sufficient, to reflect the periosteum and mucous membrane from the under surface of the hard palate and remove some of the bone as well. This, however, is a serious addition.

(*b*) When it grows forwards towards the nose, Rouge's operation with free division of the septum might give sufficient room; and in a case of frog-face, a median longitudinal incision between the separated nasal bones has been practised. Langenbeck reflected upwards the nasal bone and the nasal process of the superior maxilla, using as a hinge the skin, periosteum, and mucous membrane, connecting them with the frontal. Two incisions were made through the bone; one vertical through the nasal, the other from the anterior nares to the margin of the orbit.

(*c*) Retromaxillary growths can only be reached by excision or reflection of part of the upper jaw. Excision of the whole seems unnecessary; the orbital plate should be left, a saw-cut being made through the bone parallel to it and well below it.

Temporary resection has been practised in various ways, of which the best known is that of Langenbeck. It consists in reflecting inwards, towards the middle line, a flap consisting of part of the malar bone and the whole of the superior maxilla, bounded by the pterygo-maxillary fissure behind, the floor of the orbit above and the roof of the palate below, with the soft parts covering it. The hinge is the suture between the superior maxilla and frontal.

Incisions through everything, down to the bone, are made: (1) from the nasal process along the inferior margin of the orbit on to the middle of the malar bone, or even the zygoma; and (2) from the ala of the nose parallel to the former, as far back, and then turning upwards to join it. The origin of the masseter must be carefully detached as far as exposed. An elevator is then pushed through the posterior end of the incision down to the zygomatic surface of the superior maxilla, and carried onwards until it enters the pterygo-maxillary fissure, and can be felt under the mucous membrane with the finger passed into the mouth. In a case of polypus there does not appear to be any difficulty in this, as the pressure of the growth widens out the fissure. The incisions are then made through the bone from behind forwards, in the line of the superficial ones, the upper passing through the malar bone, the malar process and facial surface of the superior maxilla to the inner angle of the orbit, the lower parallel to this above the alveolar border. A straight, narrow saw must be used for this, the depth of the cut being guided by a finger in the mouth. As soon as this is done the included portion of the bone, with the soft parts covering it, is freed behind, above and below, and can be levered out from the pterygo-maxillary fissure, turning on its hinge in front. This exposes the orbit, the temporal fossa, the nasal cavities and the pharynx, into all of which the retro-maxillary growth may have advanced ; after the tumour has been removed the bone can be replaced and secured in position with sutures.

CHAPTER XI

INJURIES AND DISEASES OF THE MOUTH AND FAUCES

MALFORMATIONS

CLEFT PALATE

CLEFT PALATE is caused by the imperfect development of the palate process growing inwards from the superior maxillary. It may involve the soft palate only, or even the uvula by itself (bifid uvula); or the soft and part of the hard; or the whole length of both, and then it is always associated with hare-lip on one or both sides. When the intermaxillary portion is separate it usually carries three incisor-teeth, sometimes only two; and very often in these cases there is a pre-canine incisor developed, more or less perfectly on the posterior margin of the cleft. Whether this is due to the (possible) development of each intermaxillary bone from two centres, the cleft running between them; or to a reversion under conditions of abnormal development to the original number of six incisors; or whether it simply indicates a general disarrangement of the dentinal papillæ, is uncertain. Nothing is known as to the cause of the arrest, which must take place at a very early period of fœtal life. It is sometimes hereditary, and it is said that there is a distinct tendency to it, when one of the lateral incisor teeth is wanting in the parent. It is, however, more to the point that the arrest is only complete in a very small number of cases; the palate processes are seldom altogether deficient; very often one side (usually the right) is fused with the vomer; and they continue to grow for the first few years of life, so that not unfrequently the cleft actually becomes narrower, especially in front.

Syphilis often leaves median perforations, both in the hereditary and the acquired form; but the soft palate is never symmetrically defective, and there is always a large amount of scar-tissue.

Infants with this defect are unable to suck in the ordinary way; sometimes they can manage it if there is a flap attached to the teat, closing the aperture into the nostril, or if the teat is very large and thin with a hole on its under surface; in other cases they must be fed with a long-necked bottle, so that the fluid is poured quite to the back of the throat. After a time the difficulty diminishes, the tongue becoming hypertrophied and somewhat altered in shape. The growth of the palate and the ultimate success of the operation may both be seriously endangered by imperfect feeding during the first few months of life.

The time for the operation depends upon the extent of the deformity and the condition of the child: five or six years is the usual age; by that time the parts are fairly well grown and the child should be able to stand an operation. If, however, the defect is unusually great, it is better to wait a year or two than run the risk of an unsuccessful attempt. The soft palate is generally operated upon first, but Smith recommends that, unless there is some exceptional difficulty, the whole should be completed at once.

The patient is placed in the dorsal position with the shoulders raised and the head rather thrown back. An anæsthetic is not absolutely necessary, but if care is taken to watch the breathing and prevent blood passing down into the larynx, chloroform may be given through the nose by means of Junker's apparatus. Smith's gag, opening both sides of the mouth, and combining with it a tongue-depressor, is the most satisfactory, but Mason's or Coleman's should be at hand. The rings of the gag are held behind the neck by a responsible assistant, whose sole duty it is to attend to the position of the head and the breathing, especially as the continued depression of the base of the tongue may cause a little difficulty.

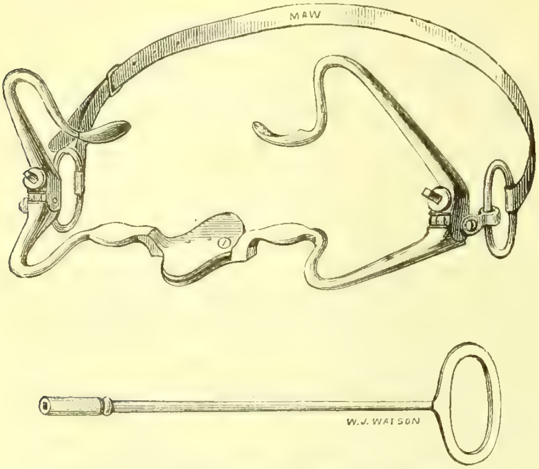

FIG. 317.—Smith's gag with tongue depressor.

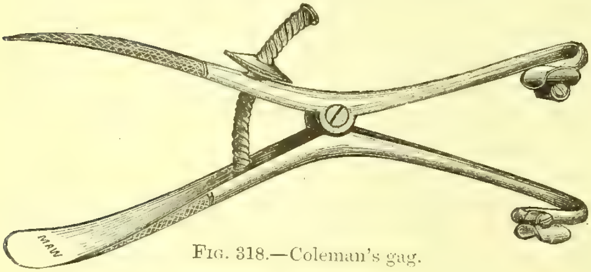

FIG. 318.—Coleman's gag.

(*a*) When the soft palate only is involved. As soon as the gag is in position and the patient anæsthetised, the tip of the uvula on one side is caught with a long pair of mouse-toothed forceps, and a flap cut from the margin of the cleft from below upwards. The other side is then seized and pared in the opposite direction. The whole of the mucous edge must be removed and care taken to obtain as wide a raw surface as possible, especially at the angle, where union fails most frequently. Fine silver wire or horse-hair is used for the sutures. If the edges fall fairly well together, the former can easily be passed with one of Smith's tubular needles (fig. 320), taking both sides in a single sweep. If horse-hair is preferred, a short curved needle may be threaded on each end and passed separately through each half of the flap with a needle-holder; or Avery's method may be employed. In this a loop of silk is passed through one side of the cleft with a needle on a handle, caught with a pair of forceps, and drawn out sufficiently far to project from the mouth. Then a single horse-hair is passed opposite to this, through

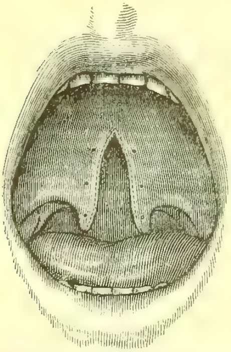

FIG. 319.—Cleft of the soft palate, showing line of incision.

the other side and threaded through the loop. When this is pulled back again, it draws the hair through the second side with it. In the case of the uvula a rectangular needle on a handle can generally be used.

The lowest suture is passed first. By drawing on this, the palate is made tense and the passage of the next is easier; the same process can be continued the whole way, the assistant keeping the ends of the sutures separate. If the edges come together readily, the fastening can be completed at once; if not, the loops must be just drawn together, so that the operator may see where the tension is greatest, and lateral incisions made to relieve it. The levator palati is the chief cause of the difficulty, but free division of the mucous membrane, especially on the nasal surface of the palate, is almost equally essential.

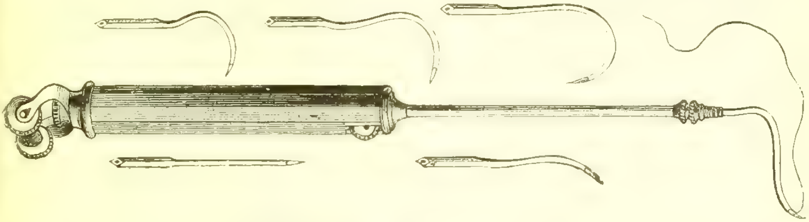

Fig. 320.—Smith's tubular needle.

A puncture is made with a sharp-pointed knife (like a tenotomy-knife on a long handle) inside the hamular process, midway between the teeth and he cleft, and on a level with the highest suture. A similar instrument, but with a blunt, rounded point, is then passed through this, and an incision made downwards and backwards through he tissues of the soft palate, as far as may be necessary. The wounds gape immensely at once, the edges come together readily, and the sutures can be tightened up, a twister or a pair of torsion-forceps being used for the wire ones. If the tension is very great, the incision may be half the length of the soft palate, but a shorter one is usually sufficient. One of the palatine branches is always divided, but the hæmorrhage is seldom serious.

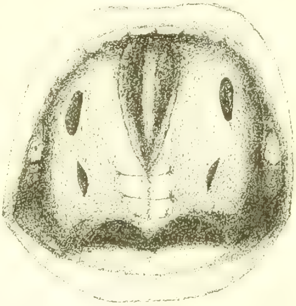

Fig. 321.—Soft palate sutured, with lateral incisions for the relief of tension. In the hard palate, site of puncture, midway between teeth and edge of cleft; and line of incision along the latter.

(*b*) When the hard palate is involved as well: the gap in this case is closed by deaching the mucous membrane (and as much of the periosteum as will come with it) from he under surface and inner side of the palate process, and displacing it owards the middle line. In front and behind the flaps are left attached, so hat they hang down like two horizontal curtains.

To separate these flaps, a puncture is made down to the bone in the entre of one side of the hard palate, midway between the teeth and the left, and midway between the anterior angle of the latter and the posterior margin of the bone. A curved raspatory is thrust in at this spot and worked owards the middle line until it projects into the cleft, detaching the perioseum before it. It is then withdrawn, a more curved one inserted into the puncture through which it protruded, and all the structures covering the hard palate, out as far as the puncture, forwards to the teeth and backwards to the junction of the hard and soft palate, completely detached. The same thing is done on the opposite side.

The next step is to divide the connection between the upper surface of the soft palate and the floor of the nose, where the fascia is especially firm. Scissors curved on the flat are used. The palate is drawn forwards, one blade passed between the flap and the bone, the other above the upper surface of the palate, and the mucous membrane cut through as far as the wall of the pharynx. The flaps now meet together easily, particularly if the palate is a high one. Wire sutures are passed and drawn together, taking care that the edges are everted; the original puncture in the centre of the hard palate is prolonged sufficiently to remove all tension, and then the sutures are twisted up.

Hæmorrhage may be free for a moment or two, but it generally stops of itself. In the case of the soft palate, it is very rarely of any consequence, and sponging is hardly required; the more this can be dispensed with the better, as it delays the operation and tends to make the patient sick. If the lateral incisions bleed, the head can be turned to one side and the mouth syringed out with ice-cold water. Detaching the periosteum is occasionally attended with a good deal of bleeding, but a sponge on a holder, pressing the flap against the bone, stops it at once. Secondary hæmorrhage from the palatine arteries, which may be very serious, must be stopped by plugging the descending palatine canal.

Respiration requires careful watching, not only on account of the anæsthesia, the position of the head, and the pressure upon the base of the tongue, but because of the danger of blood trickling down the larynx. Later, severe broncho-pneumonia, which is almost fatal to union, may arise from this.

After-treatment.—The child must be kept as quiet as possible after the operation, and only a few drops of ice-cold water allowed for some hours, for fear of causing sickness. All food must be fluid, or semi-fluid, and taken very slowly. If possible, the child should be kept in bed, at any rate for the first few days; and if it is fretful and inclined to cry, small doses of chloral may be given. The mouth should not be looked at for a fortnight; the sutures, if there is no tension upon them, may be left longer still.

Union fails most frequently at the junction of the soft with the hard palate; sometimes the whole breaks down, but it rarely happens that the flaps slough. If union is not perfect a considerable time, six months at least, should be allowed to pass before a second operation is tried. Occasionally a third or even a fourth is necessary; but in many of these a more satisfactory result can be obtained by wearing an obturator. Afterwards no pains should be spared to improve the articulation and educate the muscles. In the slighter cases, which admit of early operation, phonation may be almost perfect; but when the defect is very considerable, so that the palate, even though it is restored, forms merely a tense septum extending partially across, the accent is never lost. The fibres of the superior constrictor, extending from one hamular process to the other become hypertrophied, so as to close the communication more completely, but the flap never can vibrate properly, and not unfrequently, after some time, the cicatrix contracts and makes matters worse than they were immediately after the operation.

INJURIES OF THE MOUTH AND FAUCES

Lacerated wounds of the tongue are of frequent occurrence in epileptic fits and from falls upon the chin; and the hæmorrhage is sometimes serious. The wounds always heal by granulation, although the attempt may be made to draw the surfaces together by means of deeply placed catgut sutures.

The soft palate, the tongue, or the tonsils may be very seriously injured by foreign bodies, such as the stem of a tobacco-pipe or a piece of stick being violently driven into the mouth. The internal carotid, or what is nearly as bad, the ascending pharyngeal artery, has been torn open in this way with fatal consequences. In some cases the extraction of the foreign body has been followed by a torrent of blood; in others suppuration has taken place, usually because of some fragment left behind, and the artery has not given way for some days. In the latter case there is nearly always a warning first. If the bleeding is slight an attempt may be made to control it from inside the mouth by means of ice, or, if this fails, by turpentine or solid perchloride of iron held against the spot; but, if it is severe or if it returns, ligature of the common carotid should be performed at once. It has been proposed in these cases to tie the external as well, so as to prevent, as far as possible, the blood finding its way round through that part of the collateral circulation.

Fish-bones, pins, and other pointed structures are occasionally driven into the mucous membrane in deglutition; and at times they cause a considerable amount of inflammation. Very often they can be felt with the finger better than they can be seen.

DISEASES OF THE MOUTH AND FAUCES

Inflammatory Affections

Acute inflammation of the mucous membrane of the mouth is common in infancy and childhood, and is occasionally met with later in life, about the time of eruption of the molar teeth. It is often associated with disordered digestion, the two being dependent to a great extent upon the same cause; and it is especially frequent among the children of the poor and those who live under bad hygienic conditions. Various forms of it are described, but they seldom occur independently of each other.

Catarrhal stomatitis is the mildest: the mucous membrane swells up and becomes a brighter red; the epithelium has a sodden white appearance, and after a time is detached in patches; the tongue is raw and red, indented by the teeth; the gums are soft and spongy; and here and there the surface is marked by shallow erosions. In what is known as *follicular stomatitis* the orifice of each mucous gland is marked by a swollen bright red areola.

Aphthous stomatitis is difficult to distinguish from the last. It makes its first appearance as a group of yellowish vesicles, which break and leave superficial ulcers, about the size of a pin's head, covered with a yellowish slough and surrounded by a bright red areola. Frequently they come out in successive crops, so that all stages can be seen at the same time. They are exceedingly tender, and if on a part where they are exposed to friction they may seriously interfere with mastication.

Aphthous stomatitis must not be confused with thrush, which is an entirely different affection.

Ulcerative stomatitis, which occurs at the same time of life and under the same conditions, is more serious. The whole thickness of the mucous membrane is involved (though not the substance of the cheek, as in noma); it becomes swollen, dusky-red or even purple; then a foul greyish slough forms upon the surface; and later, when this is detached, a distinct although superficial ulcer is left. Very often the opposing surface of the gum or cheek, as the case may be, becomes infected too, so that various stages of the disease may be seen at the same time.

The symptoms depend upon the severity of the attack and the extent of surface involved. In the catarrhal form the mouth is hot and dry, the breath offensive and every movement of the tongue attended with pain; there is constant thirst and the sense of taste is altogether lost. After a time the secretion becomes more profuse, sometimes excessive, and very tender spots make their appearance, corresponding to the places from which the epithelium has been detached. In the ulcerative form these symptoms are greatly exaggerated: the gums are swollen and bleed with the slightest touch; the teeth are exceedingly tender, and movement so painful that mastication is impossible. Not unfrequently there is a considerable degree of fever, and there may be conspicuous swelling of the floor of the mouth, involving the lymphatic glands and the loose cellular tissue around; but there is never the hard brawny feeling in the centre of the cheek which marks the onset of noma.

Treatment.—Chlorate of potash rarely fails to effect a cure: it should be given locally in the form of a gargle or wash, and internally as well. In younger children borax with glycerine (well diluted) may be painted over the raw surface several times a day; or, if the case is very obstinate, alum or nitrate of silver (gr. ij ad ℥j) may be used instead. The condition of the bowels always requires attention—it rarely happens that they are acting properly; but mercurials should be avoided; and as soon as a certain amount of regularity is established, tonics, iron, cod-liver oil, and quinine should be given freely. Partly as cause, partly as consequence, these forms of stomatitis are always associated with debility and malnutrition. Other forms of stomatitis are due to specific causes.

Thrush is a superficial inflammation of the mucous membrane of the mouth and tongue caused by the growth in the epithelial cells of a fungus, the oïdium albicans, in all probability the same as the oïdium lactis. It is met with chiefly in children who are brought up by hand, and in adults suffering from exhausting illnesses. The mucous membrane of the mouth and tongue is red and swollen: its secretion is acid instead of alkaline; but the characteristic feature is the presence at the angles of the mouth of a number of minute white dots, without any red areola as in the case of aphthæ. These enlarge until they meet and fuse, so that sometimes in bad cases the whole of the interior, with the pharynx and even the œsophagus, is covered over with a thick creamy-white layer. Diarrhœa with greenish offensive stools sets in; the child is unable to take any food; the emaciation becomes extreme; sores make their appearance round the anus, and the result is not unfrequently fatal.

This disorder is due to the fungus that causes the acid fermentation of milk, and can be produced anywhere by neglect of proper precautions, especially scalding thoroughly every time they are used all the vessels which contain food and come into contact with milk. In large institutions, such as foundling hospitals, it is constantly making its appearance unless special precautions are taken, and frequently helps to cause the death of weakly children by the digestive disturbances that accompany it.

The treatment is very simple: with thorough cleanliness it soon dies out. All suspicious spots within reach should be brushed over with very dilute carbolic acid, or with borax and glycerine, and the child's mouth cleansed thoroughly after every meal. At the same time the complications that are present with it, and are in great measure due to it, the diarrhœa, loss of appetite and disordered digestion, require the strictest attention.

Mercurial stomatitis is rare at the present day: a faint red line, or a slight swelling of the gum round the necks of the teeth, particularly where there is an accumulation of tartar, is all that is seen. It may occur from inhalation, inunction, or absorption from the alimentary tract, and no doubt, though the number must be very small, certain people are peculiarly susceptible. The flow of saliva is increased; the gums, as already mentioned, become red and swollen; the breath is foul; the tongue furred and a little enlarged; the teeth feel too long; and mastication of anything hard is very painful. If this is persisted in the most fearful consequences may ensue: the mucous membrane may slough; the gums ulcerate away; the teeth fall out; the bones perish and the gangrene spread to the floor of the mouth and nose, causing the most terrible destruction. In days gone by there is no doubt the result was often fatal, partly from the constitutional disturbance and the inability to take food, partly from the continued inhalation of particles from the foul and decomposing sloughs.

At the earliest sign the administration of mercury should be stopped, and strong astringent gargles used frequently. Usually this of itself is enough. Chlorate of potash is said to be of as great service in this as in other forms of stomatitis, preventing in particular the peculiar fœtor of the breath.

Syphilitic stomatitis.—The same forms of eruption that occur upon the skin are met with also in the mouth, modified by the conditions under which they exist. They occur in the hereditary as much as in the acquired disease, and furnish a very large proportion of the cases of mediate contagion. Rhagades and the exceedingly painful fissures at the angles of the mouth have been mentioned already. Superficial sores, closely similar in appearance, are of common occurrence upon the inside of the lips. Mucous plaques and tubercles are more frequent upon the tongue, the tonsils, soft palate, and pillars of the fauces. Where the epithelium is thin, and the friction smooth and constant, they are scarcely raised; there is simply a greyish-white patch with a smooth surface and well-defined, slightly reddened border; or the epithelial covering has already been detached and a raw surface left. Symmetrical patches of this kind are often seen upon the margin of the soft palate on either side of the uvula, and may be regarded as distinctive. In other places they grow out into warty or cauliflower excrescences, often of some size; and in others, again, where they are irritated by the teeth, they cut into deep and angry ulcers.

Secondary tubercular syphilides are more rare; the epithelium, which is thrown off as scales upon an exposed surface, becomes soft and macerated in the mouth, so that the appearance they present is closely similar to that just described. In the tertiary stage, superficial and deep gummata, involving the mucous membrane, the submucous tissue, or the periosteum, are of common occurrence. Sometimes they are absorbed under treatment, and disappear without leaving a scar; more often they break down and leave deep and irregular ulcers. The favourite locality appears to be the palate. Central gummata, leading to necrosis and median perforation, are frequently met with (the presence of congenital clefts in the hard and soft palate, and occasionally of foramina in the pillars of the fauces must not be forgotten), and it is not uncommon to find the uvula and soft palate either destroyed altogether or united to the posterior wall of the pharynx in such a way that there is only a small aperture left.

The constitutional treatment does not present any special features; the local is very important. Gummata disappear rapidly under iodide of potash; ulcers occasionally require the application of acid nitrate of mercury. Secondary affections, however, may prove very obstinate. The first thing is to get rid of every kind of irritant, whether it is the sharp edge of a tooth, or tobacco-smoke, spirits, or highly seasoned food. So long as these continue to act, it is almost impossible to effect a cure. Rhagades and exuberant condylomata may be touched with nitrate of silver or brushed over with a 10 per cent. solution of chromic acid. Simple mucous patches usually get well with a wash of chlorate of potash and lotio nigra, or a very weak one of bichloride of mercury; in more obstinate cases the inhalation of calomel may be tried, or brushing the surface over night and morning with a solution of bicyanide of mercury (gr. xv. ad ℥j.), and sometimes iodoform lightly dusted on proves very beneficial, the taste and odour being concealed by mixing it with freshly ground coffee.

Tubercular stomatitis is not a common affection. Occasionally, when the tongue is involved, it occurs on the under surface of the soft palate, appearing in the form of minute vesicles which enlarge, break down, and leave superficial sores with sharply cut edges. More rarely it begins independently. There is very little inflammation as a rule; the sores slowly and steadily increase in size and depth, multiplying and fusing together until at length they develop into irregularly shaped ulcers with sinuous edges, often lying upon carious bone. There is no induration; the course at first is very chronic, and there are no large sloughs or necrosis as in syphilis, but, in spite of this, the destruction may be very considerable; I have known the whole of the soft palate eaten away. The prognosis, especially when the disease is secondary to mischief elsewhere, is very unfavourable, and the course towards the end often very rapid, in a measure owing to the pain on deglutition and the difficulty of taking food; but, occasionally, a certain amount of benefit is derived from constitutional treatment combined with scraping, iodoform, lactic acid, and similar remedies, and more rarely spontaneous (but unfortunately only temporary) cicatrisation occurs.

Other forms of stomatitis are occasionally met with. Lupus may extend from the lips to the gums and palate, and has been known to occur independently; in the latter case the diagnosis from tubercular disease must be almost impossible. Anæsthetic patches occur in the early stages of leprosy, and deep ulceration is not unfrequently the immediate cause of death in the tubercular form. A very acute variety has been described in connection with gonorrhœa; in scurvy hæmorrhagic stomatitis is one of the prominent symptoms, and in leucoplakia, when the tongue is extensively diseased, the mucous membrane of the sides and floor of the mouth is usually affected too.

PERIOSTITIS AND OSTITIS

Inflammation of the superior or inferior maxilla may be caused by extension from neighbouring structures, such as teeth; by injury after extraction of teeth or compound fracture; by mercury or phosphorus; by suppurative disease in all its forms (noma, acute suppurative periostitis, or, especially after the acute exanthemata, pyæmia), or by the action of specific organisms, such as those of actinomycosis, syphilis, tubercle, or leprosy. It may be acute or chronic, ending in necrosis or caries, according to the cause, the intensity of the attack, and the character of the bone. Necrosis, for instance, is more common in the lower jaw than in the upper, owing to its peculiar density; caries in children, in whom the bones are more vascular and less compact. When due to acute suppuration, the sequestrum may be detached within a few days; on the other hand, in phosphorus necrosis, it often does not separate for years. The amount of new bone thrown out is usually very small, but in necrosis of the lower jaw from phosphorus poisoning it is often enormous for a time and then disappears almost entirely.

In acute suppurative ostitis, whether arising from local or constitutional infection, the symptoms are exceedingly severe. Owing to the vascularity of the part and the looseness of the tissues around, the swelling is usually excessive, spreading far over the face and down the neck. The fever is often very high and the pain intense, continuing until the pus is let out by incision or finds some means of exit for itself. Then the symptoms slowly subside, the pus escapes externally or into the cavity of the mouth, and the discharge continues until either the bone recovers (for even extensive portions of the alveolar margin may be detached from the periosteum by acute suppuration, without necessarily undergoing necrosis) or the sequestrum is cut off.

Mercurial stomatitis when carried far enough to affect the bones is no less acute, judging from past accounts, for happily such cases are seldom seen at the present day. Syphilitic inflammation, on the other hand, is more chronic, and the tubercular form more so still. Phosphorus necrosis is peculiar in many ways: it does not affect those whose teeth are sound, but as soon as a spot of caries appears the inflammation spreads down into the alveolus, detaches the gum, loosens the tooth, and steadily advances until the whole ramus is involved. The symptoms are often very severe: the soft tissues around swell up and become inflamed; there is a constant discharge of most offensive pus welling up around the teeth and poisoning the breath; fresh abscesses are always forming; and partly from the continued fever and inability to take food, partly from perpetually inhaling and swallowing the foul discharge, the patient is quickly reduced to a condition of extreme anæmia (see Diseases of Bone).

Treatment.—Syphilitic periostitis and simple acute inflammation are checked at once by iodide of potash, or by painting the inflamed surface of the gum with the liquor iodi. If there is the least reason to suspect suppuration, an incision should be made inside the mouth with a sharp-pointed bistoury, the edge of which is protected up to within half an inch of the end by wrapping it round with a strip of plaster. If this is done in time the disfigurement of an external opening can nearly always be avoided. Even when there is already a soft fluctuating swelling upon the face, the incision should always be made in the groove between the cheek and gum. Afterwards the cavity of the mouth must be washed out frequently with some hot antiseptic solution (carrying it outside the teeth by means of a rubber tube), and the vessels of the skin made to contract by keeping it constantly wet with lead lotion. When dead bone is present, very little can be done until it is loose enough to come away. The teeth may be extracted if they are detached and surrounded by suppuration; incisions made to facilitate drainage; and the mouth kept as clean as possible. Carious bone may be scraped, but care must be taken, especially with children, not to disturb the germs of the permanent teeth. If any extensive defect is left, it must be bridged over with a suitable plate so as to preserve the outline of the mouth.

Alveolar abscess.—Suppuration in connection with the fangs of carious teeth is known as alveolar abscess or *parulis*. Throbbing pain, with protrusion of the tooth from thickening of the periodontal membrane, and swelling of the soft structures around the jaw are the chief features. If left, it may discharge around the tooth; more often it works its way out through the side of the jaw on to the gum (the ordinary form of gumboil); but when connected with the lateral incisors it may spread back between the layers of the hard palate and gain the surface first at its posterior margin, or burst into the nose, and, especially when the molars are involved, it has a marked tendency to open upon the face. In this case it is not unlikely to leave a chronic sinus, the orifice of which is surrounded by pouting granulations. Sometimes, owing to the tension, the consequences are even worse: necrosis is not uncommon, and even pyæmia has been known to occur.

The mouth should be washed out with water as hot as can be borne, and the gums freely lanced or leeched. Poultices should not be used. If this fails, and the tooth is much diseased, it should be extracted, or if there is any stopping this should be removed; but unless this gives free exit, or the whole abscess-sac comes away attached to the diseased fang, it is advisable to make a free incision through the swollen portion of the gum, keeping the edge of the knife turned towards the bone, and open the abscess there. The thickening along the side of the sulcus, sometimes extending under its floor, can usually be made out at once by running the finger round the inside of the cheek. If a discharging sinus persists it will usually be found on probing that there is either a small sequestrum, or more frequently an old fang left, keeping up the irritation.

Suppuration in the Antrum

This may result from injury: from dental caries and alveolar abscess (the fangs of the first molar project into the cavity, and those of the second bicuspid are only separated by a thin plate of bone): or from disease of the mucous membrane of the nose. In this case the teeth are sound and free from pain, or are only involved secondarily, occasionally becoming loose and dropping out of themselves from absorption of the alveoli.

The natural orifice of the antrum is rather high up on the floor of the middle meatus, and is rarely closed. Even when it is the inner wall is so thin that it usually gives way elsewhere. Sometimes, however, the secretion is pent up; the tension rises; suppuration sets in, and the attack becomes very acute.

When this occurs the pain is most intense: generally it is deep-seated; often it is referred to the teeth, and usually it radiates all over that side of the face and head. The walls of the cavity yield and bulge outwards in all directions, as in the case of rapidly growing tumours. The side of the face is tender and swollen; the skin is reddened and pits on pressure; the nostril is blocked up; the teeth are loosened and exceedingly painful, very often they feel too long; and the floor of the orbit may be pushed upwards, until vision itself is seriously interfered with. If the finger is passed under the upper lip, the anterior wall can be felt projecting into the mouth; and occasionally the bony plate is so thin that it crackles. Sometimes there is a rigor, and always there is serious constitutional disturbance. Such cases, however, are certainly rare; nearly always the wall gives way at some spot, and the acuteness of the symptoms is relieved at once; and it does not seem unlikely that most of the cases of acute suppuration of the antrum are really deep-seated periosteal abscesses in connection with the roots of the teeth, and are in the thickness of the wall.

In chronic inflammation, on the other hand, the occasional discharge of fluid from the nostril, when the patient lies down with the affected side of the face uppermost, is sometimes the only sign. If it is merely catarrhal, associated with polyi, the fluid is of a clear watery character; if there is suppuration it is thicker and generally offensive: but it differs from ozæna in this, that the smell is perceptible to the patient, but not, unless by blowing the nose the cavity is emptied of its contents, to the by-standers. Moreover, there are no crusts of dried and inspissated mucus. Occasionally the discharge finds its way through the posterior nares and is swallowed.

In one case quoted by Heath the cavity was filled with thickened caseous pus, and the bone was enlarged, hard, and tender, so as to simulate a solid tumour of the jaw; as a rule, however, there is no distension. Attacks of neuralgia, with a constant dull aching pain, and sometimes frontal headache, as when the frontal sinus is involved, are nearly always present. The teeth and the bone around are tender, and the former may become loose and drop out; the side of the face, and especially the eye-lids, are swollen and puffy from time to time; and not uncommonly the patient's health suffers severely from the constant swallowing of an offensive discharge.

When the suppuration is chronic the diagnosis rarely presents any difficulty, though it is probable many of the cases are overlooked and regarded merely as inflammation of the mucous membrane of the nose. The acute form resembles in some respects a rapidly growing sarcoma, especially as this is often attended with pain and a considerable rise of temperature; but the symptoms are much more severe. In any case of doubt an exploratory puncture should be made under the lip.

The treatment consists in letting out the pus, draining the cavity thoroughly, and if necessary washing it out with an antiseptic or mild astringent. In some cases the cavity can be readily cleared from the middle meatus of the nose by means of a Eustachian catheter. If this does not succeed, an additional orifice must be made elsewhere. If any of the teeth which are ordinarily in relation with the antrum are decayed and carious, the stumps should be extracted, and if the cavity is not opened a trocar driven through the remaining portion of the bone, care being taken that it does not slip in too far. Afterwards a drainage-tube, that can be stopped at will, must be inserted in the opening to prevent its closing and to keep the food from passing up into the cavity, where it would decompose. If, however, the teeth are sound, or if they have already been extracted, and the alveolar margin has become thickened and dense from sclerosis, the opening must be made either through the anterior wall, under the upper lip, behind the canine, or through the nose. The former of these is to be preferred when the wall is at all bulged or is inclined to yield beneath the finger. The latter is better under other circumstances, provided there is sufficient room in the nostril. The opening is most easily made in the lower meatus, just under the middle of the inferior turbinate bone, where the inner wall is fairly thin. There is no difficulty in perforating the bone, and, if there is a necessity for it, the patient very soon learns to wash out the cavity through the opening for himself. As a rule, however, if a second opening is made, and the interior is once thoroughly cleared of its decomposing contents, the secretion soon regains its natural character.

Hydrops Antri, or Dropsy of the Antrum

The facial surface of the upper jaw occasionally becomes immensely distended by a collection of clear yellowish serum containing a few crystals of cholesterin. The enlargement is very gradual, quite painless, and sometimes involves the palate and nasal surfaces as well. The bone becomes so thin that it crackles like parchment, and it may even be completely absorbed in some places. If the fluid is evacuated, the swelling subsides, the maxilla resumes its normal relations, and the opening very soon closes in.

It was formerly held that this dilatation was due to an accumulation of the natural secretion of the mucous lining of the cavity, the opening into the nose having in some way or other become closed. According to Heath, however, it is certain that some of these cases, and very probably all, originate as cysts in the anterior wall of the antrum ; and that either they grow to such a size as to be mistaken for the cavity itself, or that the intervening wall is gradually absorbed by the pressure, and the two cavities thus placed in communication with each other.

Closure of the Jaws

Inability to open the mouth may arise from muscular spasm, from acute inflammation of the bones or soft structures, or from cicatricial contraction and other organic changes caused by previous attacks of inflammation.

(*a*) *Muscular.*—The simplest example is the contraction of the muscles of mastication, which not uncommonly attends the eruption of the wisdom-teeth ; sometimes apparently it is hysterical, and, occurring as trismus, it is one of the early symptoms of tetanus. The contraction disappears at once under an anæsthetic, allowing the interior of the mouth to be thoroughly examined ; and then, if the wisdom-tooth is found to be growing forwards against the next, or if it is covered in, steps may be taken to release it. Generally it requires removal, but occasionally this is impossible, and the next has to be taken away before it is sufficiently accessible. Hysterical contraction is characterised by the peculiar manner in which it returns after the anæsthesia is past, not slowly and quietly, beginning with the return of consciousness, but quite suddenly, long after all the reflexes, and not until the patient's attention is drawn to it.

(*b*) *Inflammatory.*—All forms of acute inflammation, whether involving the lower jaw itself, the tonsil, parotid gland, or other structures in the neighbourhood, are attended by a certain degree of inability to open the mouth, partly owing to the pain, partly to the mechanical difficulty caused by the inflammatory exudation poured out in the loose cellular tissue. The treatment, of course, depends upon the primary cause.

(*c*) *Permanent closure.*—This may arise from cicatricial contraction of the soft parts, consequent on noma or gunshot injury destroying a large portion of the cheek, or from affections of the joint. In one or two instances the coronoid process has become anchylosed to the upper jaw after long-continued inflammation. Unreduced dislocations, after a time, acquire considerable mobility, although the incisor teeth cannot be brought into apposition.

If the cicatricial contraction involves both the mucous and cutaneous surfaces, the only satisfactory way of dealing with it is by plastic operation after excision. Stretching the bands and simple division are quite useless. A double flap must, of course, be used—the inner one, if possible, being composed of mucous membrane. In cases in which the whole thickness is not involved, Heath recommends that the cicatrix should be freely divided and a metal plate or shield adjusted on the teeth so as to fit in between the gum and the cheek, and prevent the formation of fresh adhesions. A kind of mucous membrane is gradually developed in the groove, but this mode of treatment is naturally only practicable in a very limited number of cases.

Anchylosis of the lower jaw is caused either by chronic suppurative arthritis (consequent on injury, pyæmia, suppurative ostitis, or tubercular disease) or by a peculiar form of rheumatism, often the relic of an acute attack, which eads to the production of dense fibrous adhesions, and not unfrequently bstinately returning again and again, ends at length in synostosis. Naturlly it is a condition of considerable importance, not only from the intererence with mastication, but from the grave danger of asphyxia in case of omiting.

Treatment.—The joint may either be excised or an artificial one made n front of the fixed point. The former operation is only of limited value. An incision an inch and a half in length, not deeper than the subcutaneous ellular tissue, is carried downwards and slightly forwards from the supralenoid root of the zygoma. The temporo-facial branch of the seventh erve must be found and pulled downwards, the lobules of the parotid gland ushed aside, and the neck of the condyle divided with a chain saw, without pening the buccal cavity. The head may then be detached with a chisel or utting-forceps, and levered out; but, especially in those cases in which the ones are dense and sclerosed as a result of chronic ostitis, the operation is xceedingly difficult.

Linear osteotomy has been performed through the condyle itself; below his through the neck; farther down at the base of the coronoid; and, ccording to Rizzoli's method, through the mucous membrane, without an xternal scar; but all of these labour under the same objection, that osseous nion is almost certain to occur.

Esmarch's operation (excision of a wedge-shaped portion of the ramus) is ore satisfactory. An incision is made along the lower margin, in front of the angle, the soft parts separated, and a triangular portion of bone with its apex upwards, and the base, about an inch in length, corresponding to the lower border, detached and removed. A deep groove is cut on the external surface with a saw first, and then the section completed with cutting-forceps. Bennett, who performed this operation on both sides in a case of rheumatic synostosis, in which all milder measures had failed again and again, recommends that, at least in cases of this disease, the insertion of the masseter should be detached from the bone on the distal side of the incision, or the two fragments are certain to be drawn together. The patient recovered with very good upward and downward action.

TUMOURS

1. In connection with the Soft Structures

Nævi are not uncommon upon the gums, lips, and inside of the mouth. In one case under my care the whole thickness of the cheek was involved.

Congenital hypertrophy of the gums is a very rare affection, requiring free excision. It must be distinguished from local hypertrophy, growing out in a polypoid form, the result of constant irritation, for which a much more limited operation will suffice.

Papillomata may occur upon the gums in the neighbourhood of the teeth, upon the lips, or upon the inside of the cheek. In some cases they are low and can scarcely be distinguished from ordinary warts; in others, however, they are compound or branched and covered over with exaggerated filiform papillæ, similar to those that are occasionally seen in what has been called ichthyosis linguæ. It is probable that they are the product of constant irritation (I have known them develop symmetrically upon the upper and lower lips from perpetual smoking); and they should always be freely removed for fear of something worse developing as age advances.

Adenomata are rare, but they are occasionally found on the lips, palate, gums, and, in short, in all parts in which mucous glands are abundant. They form soft, irregularly-shaped, but flattened swellings under the mucous membrane. Their growth is slow, but it is generally difficult to ascertain how long they have been present. In microscopic structure they present a close resemblance to the gland-growths that are found in the parotid, and sometimes, like these, are cystic and contain bone and cartilage. For the most part they are made up of irregular masses of acini and ducts.

Mucous cysts are often met with upon the inside of the lip (labial) or cheek (buccal), developed from the mucous glands, and forming rounded, tense swellings rather dark in colour. The contents are translucent, but very viscid; and occasionally undergo calcareous degeneration. It is sufficient to remove a portion of the wall, but in many cases the whole can be excised without difficulty.

Ranula is the term applied to a cyst of the floor of the mouth, in many respects resembling those just described. It forms a soft, lobulated fluctuating swelling, usually of a bluish-purple colour, and lies immediately under the mucous membrane, on one side of the frænum linguæ. When small it gives rise to little inconvenience, but as it grows it pushes the tongue on one side, interfering with deglutition and articulation, projects in the submaxillary region, and may even reach down into the neck. The wall is composed of fibrous tissue lined with epithelium which is sometimes ciliated; and the cavity is filled with a clear viscid fluid that bears no relation to saliva.

Ranula is probably developed from a mucous gland (that of Blandin or Nuhn) which is present in this situation; it has nothing to do with the duct that runs by the side of it. It has been known, however, to originate in connection with the sublingual gland, and it is probable that in many doubtful instances it is the product of cystic dilatation either of normal mucous glands occupying this region or of outlying portions of the larger ones which have been in some way detached in the course of development. It is very questionable whether ranula in the strict sense of the term ever develops from the sublingual bursa, although it is quite possible that this may become cystic.

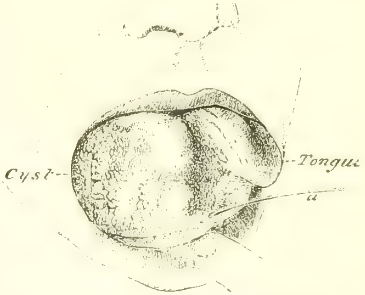

FIG. 322.—Ranula or sublingual cyst, with salivary duct lying upon it.

The treatment of ranula is a little difficult on account of the obstinacy with which it returns. Excision of the whole cyst is a serious operation, involving a considerable degree of dissection among very vascular structures. Removal of a portion of the wall only is seldom of any use unless further steps are taken to secure its obliteration. So much may be cut away that it cannot close: the interior may be wiped out with caustic, so as to excite a certain degree of inflammation; a V-shaped flap may be made and the apex stitched down to the floor; or a wire or silk seton may be used. The milder measures should be tried first, as severe inflammation may result if the sac wall is made to slough.

Dermoid cysts.—Cysts containing sebaceous matter and hairs are occasionally found in the floor of the mouth, chiefly in the middle line, and in the substance of the tongue. They are always of congenital origin, although they may not enlarge until adult life, and are due either to accidental implantation, or to the persistence and cystic degeneration of fœtal structures, such as the hyoglottic canal, which commences at the foramen cæcum. Their position, the absence of inflammation, and the exceedingly slow enlargement are the chief diagnostic features, but it is rarely possible to be certain without a preliminary puncture.

Other forms of cysts are very rare, although one or two instances of hydatids are on record.

Epithelioma (squamous) is the only form of malignant disease that is at all common. It develops not unfrequently from the continued irritation of ill-fitting plates, and requires the freest removal. The diagnosis from simple ulceration is not difficult if the part is examined carefully, but the chief interest of this disease is the relation that it bears to a variety of cystic degeneration of the jaws.

2. GROWING FROM THE BONES AND PERIOSTEUM

Partly owing to the great variety of the tissues that compose them, partly to the constant irritation to which they are subjected, the jaws are exceptionally liable to become the seat of new growths and cysts. All the tumours that develop in connection with bone may occur, and, in addition, others that form from the teeth, the fibrous tissue of the gum, and the epithelium. The term *epulis* is applied to those that grow from the alveolar margin at the neck of the teeth, springing from the periosteum or the periodontal membrane. Strictly, it should be limited to the hard fibromata which are common in this region, and which often extend so far down the socket of the tooth that a considerable portion of the alveolar margin has to be excised in order to ensure its complete removal.

Fibromata, composed of peculiarly dense fibrous tissue, with often spicules of bone, and sometimes islets of cartilage in their interior, are the most common. For the most part they grow from the periosteum and form pedunculated tumours, projecting under the mucous membrane. More serious ones, however, are met with occasionally, springing from the interior of the antrum, or from the inferior dental canal, or from the sockets of some of the teeth, and attaining an enormous size. In all cases they require free removal, but provided this is properly done there is no fear of recurrence.

Enchondromata are much more rare, and many of them become converted into bone. Occasionally, when they originate from the antrum, they attain an enormous size, though of very slow growth, and lead to great deformity. Like the former, they may begin either in the substance of the bone or under the periosteum, and they require free removal. It seems probable that those which are stated to have recurred were either not thoroughly excised, or were in reality chondrifying sarcomata.

Ivory and cancellous exostoses are occasionally met with. The former generally grow either in the antrum or from the angle of the lower jaw. The latter may be formed from cartilage, but very often are covered in with an unusually thick layer of compact tissue. Sometimes they originate in the interior of the bones, and in many cases they are so ill defined that it is impossible to draw a distinct line between them and that peculiar form of hyperostosis or overgrowth of the jaw which is occasionally met with in young people, and which in its turn is very difficult to distinguish from the milder forms of leontiasis.

Exostoses must be carefully separated from bony outgrowths due to displaced or supernumerary teeth, which are by no means uncommon.

Odontomata, or tumours formed in connection with the teeth, may be either mere outgrowths (exostoses of the fangs) composed chiefly of cement, or, much more rarely, gigantic misshapen masses of dentine, enamel, and cement, thrown together with more or less of order and arrangement. They have only been met with in the lower jaw and in young people; and in all probability they spring from the germs of one or more of the molar teeth which have become displaced and have grown out into an irregular mass, sometimes as large as a turkey's egg. The symptoms to which they give rise are very indefinite. Unless the surface protrudes through the gum, there is merely a slow growing tumour, causing immense expansion of the lower jaw; and it has happened on several occasions that large portions of the bone have been excised under the impression that there was a centrally placed malignant growth. One tooth is always absent from the series, and occasionally the growth of the neighbouring ones is interfered with to such an extent that they remain buried in the substance of the jaw. If the nature of the case is recognised there is no difficulty in removing part of the wall of the cyst, and detaching the mass from the fibro-cellular membrane surrounding it.

Myeloid sarcoma may develop either in the interior of the lower jaw—forming a rounded, tense, and elastic swelling, often suspiciously like a cyst, only of more rapid growth—or under the periosteum. In this situation it is sometimes called myeloid epulis, and is distinguished from the ordinary fibrous form by its darker colour, which shows distinctly through the mucous membrane. Of all the sarcomata it is the least malignant, and may never recur if excised freely. In the upper jaw it usually grows from the antrum, and is softer and more vascular, containing frequently a very large proportion of round or spindle cells.

Round-celled and spindle-celled sarcomata are intensely malignant. They may spring from the periosteal surface of either jaw, but their favourite seat is the antrum, in which they grow with very great rapidity, thrusting the walls out in all directions and extending into neighbouring cavities. The nostril becomes blocked; the floor of the orbit is raised and the eye-ball protruded; the hard palate is forced down; the facial surface is thrust forward; and the whole side of the face seems enlarged. Then in a short time the growth spreads into the pharynx, or extends down the sockets of the teeth, detaching them and forming a fungating mass on the alveolar margin; or it grows out into the nose and simulates a polypus, or involves the skin of the face. Nothing else in so short a time can produce so great or so general an enlargement. Free removal of the whole bone is essential, but very often the disease is already too far advanced before the patient is aware of the gravity of the affection. Rapid recurrence is the rule, the secondary growths being generally softer and even more malignant than the primary.

Sarcomata growing from the jaws, like those of other bones, occasionally undergo partial chondrification or ossification, forming what used formerly to be described as osteoid cancer and malignant enchondroma. Cystic degeneration is not uncommon, especially in the myeloid form.

Primary carcinoma does not occur in the jaws, but secondary growths, extending in the case of the upper jaw from the nasal mucous membrane (tubular epithelioma), or from the palate surface (squamous), are not uncommon, and, without any great external show, lead to complete destruction of the bone: a probe, for example, may pass through a small, comparatively insignificant, opening in the palate into a great ulcerated space. In the case of the lower jaw ingrowths of epithelial cells in the form of columns are met with in connection with multilocular cysts.

Cysts.—Both the upper and the lower jaws are frequently the seat of cystic disease, which may originate in connection with the mucous membrane, or the teeth, or be dependent upon the degeneration of new growths, sarcoma or epithelioma.

Mucous cysts are chiefly found in the antrum, developing from the glands lying in it, and are very generally associated with the presence of polypi. The mucous and submucous tissues, as in the nose, sometimes undergo chronic hypertrophy; when the fibrous portion predominates, a polypus results; when it is the glandular part, cysts are produced. These are usually multiple, rarely attain any very large size, and contain a clear mucous fluid. Sometimes they cause a certain amount of absorption of the bone upon which they rest.

Dentigerous cysts.—Cysts formed in connection with the teeth are either due to an error of development, or are the result of chronic irritation and inflammation. The former are known as dentigerous cysts. One of the permanent teeth, generally the canine, remains buried in the jaw; the fluid which normally collects between the enamel organ and the surrounding tissues, as the tooth approaches the surface, gradually increases in quantity; a certain degree of tension is caused; and by degrees a cyst is formed deep in the substance of the bone, lined with soft but thick membrane. The tooth at first is attached to the wall at one spot, but subsequently it becomes free. The diagnosis rarely presents any difficulty: the swelling is always met with in young adult life; one of the permanent teeth is missing from the series, and very often the temporary one has not been detached; the outer side of the jaw especially is expanded; the surface is perfectly uniform and painless; and sometimes, on deep pressure, a certain degree of crackling can be made out. Occasionally they are formed in connection with the other teeth, and a few instances are recorded in which the temporary teeth, and even supernumerary ones, were associated with them.

Subperiosteal cysts.—The other form of dental cyst is met with at any age, and appears to be the result of chronic irritation in connection with the fangs. From their situation under the lining membrane of the alveoli, they are sometimes known as subperiosteal. Fluid collects round the root of a carious tooth, the bone is absorbed, a lining membrane is formed, and at length a distinct cyst is produced, which may or may not be attached to the tooth. At first its contents are thick and semi-purulent; later, as the pus undergoes fatty degeneration, they become softer, cheesy, and at length serous. Cholesterin crystals are generally present in abundance. These cysts are rarely larger than a hazel-nut, but sometimes, when they are situated in the anterior wall of the antrum, they encroach upon its space to such an extent that they may easily be taken for it, and it is not improbable that many of the cases of so-called hydrops antri are really to be accounted for either by the presence of one of these cysts in the wall or by one having ruptured into the cavity.

The symptoms, when the cyst is sufficiently large to give rise to any, are merely those of a chronic, painless enlargement of part of the jaw. As a rule, by the time it is large enough to form a projection, the wall over it is absorbed, and there is merely a thin crackling plate of bone which yields beneath the finger. The treatment consists in free incision of the cavity, exploration to make sure there is no persisting cause, such as a misplaced or supplementary tooth, and drainage.

According to Heath, periosteal cysts occur in the lower jaw without any apparent immediate connection with the teeth, though very possibly some irritation connected with those organs may have been the original cause of the mischief.

Cysts that develop in connection with myeloid or other sarcomata rarely admit of diagnosis, and do not possess any practical importance.

Multilocular cysts, on the other hand, the so-called cystic sarcomata, are of great interest. They are more common in the lower jaw than in the upper, and originate, in most instances, in some form of injury, or from the irritation of decayed teeth. Formerly they were regarded as simple cysts, but it has been shown that they are really of epithelial origin, due to the downgrowth of columns of cells from the surface into the interior of the bone. As a result, great cellular spaces are formed inside, and the internal and external plates are so far separated from each other that in extreme cases the alveolar portion of the horizontal ramus is reduced to the condition of a few scattered trabeculæ, and the teeth are completely detached. The central cells in the larger columns undergo colloid degeneration, and in this way cysts are formed, filled with a thin, glairy, or blood-tinged fluid, and surrounded by imperfect layers of columnar epithelium. Their growth is very slow, and, probably owing to the bony capsule and to the early degeneration of the epithelium, they have but little tendency to implicate surrounding structures or the lymphatic glands. In one or two instances, however, sarcomatous tissue has been found associated with them, and then the prognosis is not so good.

Owing to the fact that the alveolar margin and the sockets of the teeth are much more involved than the lower, firmer portion of the horizontal ramus, it is possible, in many cases, to excise the whole of the growth from the mucous surface, scraping it away freely, without removal of the whole thickness of the bone. Whether this should be done or not depends chiefly upon the age of the patient and the amount of solid tissue present. In case of any recurrence, the whole affected portion should certainly be removed.

OPERATIONS ON THE JAWS

Excision of the Upper Jaw

This may be complete or partial, not removing the floor of the orbit. Where possible the latter is to be preferred, as it causes less deformity and does not expose the eye-ball to the risk of displacement or injury. In cases of sarcoma, for which this operation is most frequently performed, free removal of every part of the bone is essential.

The patient is placed in a semi-recumbent position with the head and shoulders well supported. The anæsthetic must be administered by means of Junker's apparatus, the tube being passed through the other nostril or the mouth, according to the convenience of the moment. A preliminary tracheotomy is not necessary, although it is a wise precaution when hæmorrhage is expected, but the administrator must pay special attention to the breathing, and particularly to the danger of blood finding its way down the larynx.

The incision (usually known as Fergusson's) runs down the centre of the upper lip, round the ala of the nose to the inner angle of the orbit, and along its lower margin as far as the malar prominence. The arteries of the lip are the only ones that bleed, unless the growth has infiltrated the skin. The flap is reflected far enough to expose the whole of the bone that requires to be removed.

An incisor-tooth is drawn, and an incision made with a stout scalpel along the floor of the nose, down the hard palate in the middle line, and transversely outwards at its posterior margin toward the last molar. The object is to preserve the soft palate when the bone is removed, the separation being completed with blunt-pointed scissors. The ala of the nose and the periosteum of the orbit are to be detached in the same way.

The bones may be partially divided with a saw or cut through at once with a pair of long-handled bone-forceps. The latter is the more speedy and does not really lead to more splintering. One blade is passed into the mouth, the other down the nostril, and the hard palate divided with a single cut; the nasal process is treated in the same way, and then the outer angle of the orbit, the line of division running into the spheno-maxillary fissure. By this the bone is practically freed, and if grasped with a pair of lion-forceps, one set of teeth fixing themselves in the hard palate, the other on the malar eminence, it can be easily detached by wrenching it from side to side and separating the soft structures as they resist with a pair of blunt-pointed scissors. There is seldom any hæmorrhage; the arteries divided are all minute and if torn across retract at once. Sometimes however, when the growth is very rapid and the vessels much dilated, it is fairly free; and if the substance of the tumour (in which the vessels are often little more than open channels) is torn, it may be of any extent. It must be stopped by pressing a sponge firmly against the bleeding part, or, if this fails, with the actual cautery.

If the whole growth has been removed and the bleeding stayed, nothing further need be done; the flap is simply replaced and fixed with two or three sutures, a hare-lip pin being used for the lip. If however the bone is crushed by the forceps, or if the surface of the growth presents a torn and ragged surface, the wound must be carefully examined, and the rest either removed with a sharp spoon or destroyed by packing the cavity with lint covered with a paste made of chloride of zinc and starch. Sometimes it is necessary to plug the space with strips of iodoform gauze in order to check the oozing; but, whatever material is used, it must be withdrawn at the end of twenty-four hours, owing to the rapidity with which it becomes foul, and partly for this reason, partly from the pain it causes, it should be avoided whenever it is possible.

The after-treatment is very simple and the deformity left strangely slight. The lower eye-lid however may become œdematous, especially when the floor of the orbit is removed, and cause a very unsightly projection; and, in cases in which it is necessary to remove the malar bone as well, the prominence of the cheek of course is lost, so that the depression becomes more conspicuous.

Partial operations are much more common. The floor of the orbit may be left, the bone being sawn across below the infra-orbital foramen; or the incision may be confined to the side of the nose and the anterior wall of the antrum exposed sufficiently to allow a tumour to be gouged out from the interior; or large portions of the alveolar margin with the teeth may be removed from the inside of the mouth in cases of epulis. Temporary resections, in which more or less of the bone is separated from the rest and reflected without dividing the periosteum or soft tissues, have been described on page 869.

EXCISION OF THE LOWER JAW

This may be either complete, the symphysis being divided and the condyle disarticulated, or partial; and it may be performed altogether from the inside of the mouth, or through an external incision. The former operation, except in the case of such diseases as phosphorus necrosis, is exceedingly difficult and dangerous from the risk of wounding the facial and maxillary vessels in a part that is almost inaccessible from the interior; the latter involves a cicatrix of some extent (depending upon the amount of bone that requires taking away), but if the red portion of the lip is not divided, and the incision is kept under the horizontal ramus, it is scarcely noticeable. The facial artery must of course be divided, but the nerve does not suffer unless the incision is carried unnecessarily high up the posterior margin of the vertical ramus.

If one-half of the bone is to be removed, a vertical incision is made through the lip, and a horizontal one at right angles to this, along the inferior margin as far as the angle, and up behind the vertical ramus to a level with the lobule of the ear. The soft tissues are dissected off the external surface of the bone and reflected upwards ; the jaw divided near the symphysis, one of the teeth being drawn for the purpose, and the structures on the inner side separated in the same way. The bone should be sawn nearly through and the section completed with bone-forceps ; and care should be taken when the division is near, and still more at the symphysis, that the tongue does not fall backwards. The facial artery should of course be secured at once.

The anterior end of the detached half must now be grasped with forceps and pulled down to complete the separation of the masseter and internal pterygoid. For the latter the bone must be everted. Then, if it is intended to disarticulate, either the temporal muscle must be detached from the coronoid or this process cut off with bone-forceps and left for excision later. If it catches against the malar bone while it is being depressed this must be done. As soon as this is effected, the jaw can be depressed a great deal farther, and by keeping the point of the knife well against the bone the long internal lateral ligament (with the inferior dental nerve and artery), the capsule and part of the external pterygoid can be divided. The jaw then comes away readily, the rest of the soft structures being divided one by one with blunt-pointed scissors. Great care is required not to divide the internal maxillary artery, which lies outside the internal lateral ligament, between it and the bone, or to tear it by everting the ramus too much and twisting it round the neck of the condyle.

Partial excision, leaving the condyle and the coronoid process, is more easy. In many instances slighter operations still are possible : a segment of the horizontal ramus only may be removed (when this is done the division of the jaw should be nearly completed in both lines of section before either is carried right through, or in making the second the support of the jaw is lost) ; or, as in epulis and occasionally in epithelioma, the alveolar portion may be taken away and the lower border left.

CHAPTER XII

INJURIES AND DISEASES OF THE TONGUE, SALIVARY GLANDS, AND TONSILS

CONGENITAL AFFECTIONS OF THE TONGUE

Tongue-tie is caused by the frænum being of unusual shape or size: it may be too broad or attached too far forwards. In the vast majority of instances this affection is imaginary, but cases are met with in which it renders sucking very difficult, or, later, interferes with articulation. The mucous membrane should be divided with a pair of blunt-pointed scissors, and sufficient separation effected by tearing.

The opposite condition, undue laxity of the frænum, so that the tongue can sink backwards, with its dorsum against the wall of the pharynx and its base over the glottis, is much more rare. Several cases, however, are recorded in which it is stated to have caused death. The same thing has been known to occur after very complete division of the frænum.

Fixation to the floor of the mouth by folds of mucous membrane, absence of the tongue altogether, bifid tongue, and other defects are very rare.

Macroglossia.—One or two examples of true hypertrophy of the tongue, involving all the component structures, have been recorded, but by macroglossia is generally understood an enlargement of a different character. It affects only the connective tissue, lymph spaces and lymphatics, which are enormously dilated. The blood-vessels are occasionally larger than natural, and in some instances a certain amount of adenoid growth has been described; but there does not appear to be any increase in the number or size of the muscular elements.

Macroglossia is nearly always congenital and is occasionally associated with hydrocele of the neck; but it is often not noticed for some time after birth. In the few instances in which it appears to have developed late in life it has followed injury, inflammation, or the acute specific fevers, its pathology in all probability being essentially the same. The enlargement that is met with in cretins, idiots, and others of weak intellect, is merely the result of inflammation consequent upon repeated protrusion and injury.

The appearance is characteristic. The shape of the tongue is more or less natural, but it protrudes many inches beyond the mouth, and the surface is covered with enlarged papillæ, often bulbous at the ends, and separated from each other by deep smooth-walled fissures. The general colour is paler than natural, and it has a delicate semi-translucent appearance on the surface. In the slighter cases it can still be withdrawn; in those which have already lasted some length of time this is no longer possible: the mouth cannot be closed; the saliva dribbles away; the lower lip becomes everted, and the chin covered with eczema; even the lower jaw is enlarged and the teeth forced down by constant pressure until they are practically horizontal. Then the protruded portion of the tongue begins to suffer. From constant exposure the surface becomes hard, dried up, cracked, and ulcerated; repeated injuries from the teeth, which are always rubbing against its under surface and its sides, and other causes, lead to attacks of inflammation, each of which brings a fresh amount of œdema and leaves the condition worse than it was before; and at length, partly from the discomfort, partly from the difficulty of introducing food (not so much the swallowing of it), the patient's condition becomes one of absolute misery.

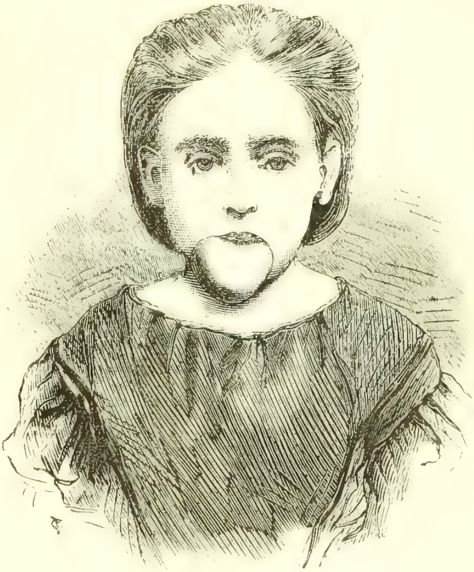
FIG. 323.—Macroglossia.

The only treatment that can give permanent relief is the excision of a V-shaped portion; and this should be practised in all cases in which the contour of the lower jaw and the direction of the teeth are becoming affected. If the thickness is very great the natural shape of the tongue may be partially restored by excising a horizontal as well as a vertical wedge, the surfaces being brought together by catgut sutures running through the whole thickness. In cases of recent injury when the tongue is more than usually swollen, soft linen moistened with glycerine may be wrapped round it to reduce the œdema, although of course it has no effect upon the permanent hypertrophy.

INFLAMMATION OF THE TONGUE

The mucous membrane of the tongue, like that of the mouth, is liable to all the varieties of superficial ulceration that have already been described. Aphthæ may form upon the tip and edges; thrush may occur in infants and adults whose health has broken down; herpes is occasionally seen; and ulcerative stomatitis sometimes extends on to it from the cheek or palate. In addition to these, however, and to the various kinds of specific disease, such as syphilis and tubercle, the tongue is especially subject to certain forms of chronic inflammation, some superficial and spreading over the greater portion, others local and ending in deep ulceration. These are due, there is no doubt, to the constant injury and irritation to which the surface is exposed; but they are also very largely dependent either upon individual predisposition or the general state of health. The same irritant—tobacco smoke, for example—which may be continued in one case for years without producing the least effect, in another causes serious irritation within a very short space of time; and a ragged tooth, which may not hurt so long as the general health is good, cuts into the tongue and leads to ulceration as soon as it begins to fail. It is possible that in this case the condition of the tongue itself is sufficient explanation : it becomes enlarged and flabby; the teeth cut into it ; and the epithelium covering it may be more delicate than natural ; but this is certainly not satisfactory in the case of the former, nor will it account for the obstinate persistence of some of these varieties of inflammation when they have once commenced.

Acute Glossitis

Acute inflammation of the tongue may be caused by cold, mercury, poisoned wounds, the presence of foreign bodies, or the stings of insects. It has also been known to occur in the course of erysipelas and some of the eruptive fevers. The mucous membrane only may be affected, or the whole substance of the tongue ; and it may end in speedy resolution, in a circumscribed abscess, or in a most acute form of diffuse inflammation, which spreads to the floor of the mouth, involves the aperture of the larynx, and not unfrequently proves fatal from asphyxia or septic poisoning.

There is no difficulty in the diagnosis. The surface is dark and livid, the dorsum covered with fur; the size increases so that it is tightly pressed against the teeth, and movement is attended with severe pain. If the inflammation continues the swelling soon becomes enormous ; the tongue fills the mouth, protrudes between the teeth, presses up against the palate and projects backwards over the glottis. The tissues at the floor of the mouth become swollen and tense, so as to raise it farther still ; the mouth cannot be shut ; the saliva pours away ; articulation and deglutition are impossible ; and there is imminent danger of asphyxia. The pain in acute cases is very great and there is fearful distress, but the temperature is seldom high. As the inflammation subsides, superficial sloughs not uncommonly make their appearance where it has pressed against the teeth, leaving troublesome ulcers ; or this is followed by a condition of chronic induration and enlargement ; or, in very rare cases, by persistence of the sloughing, until, if the patient does not succumb from septic poisoning and broncho-pneumonia, the whole organ is practically destroyed.

The treatment depends upon the severity of the attack. In the milder cases, in which the distress is not urgent and there is no immediate fear, the bowels should be opened freely with a saline purge, chlorate of potash given internally, and the mouth washed out constantly with an ice-cold solution of carbolic acid or permanganate of potash. Fragments of ice may be sucked meanwhile. In the more severe ones, when the mouth is nearly filled, leeches may be applied behind the angles of the jaws, and careful examination made with the finger over the dorsum of the tongue as far as it will reach. If a special projection can be felt, or even if there is merely a difference in consistence, a puncture should be made with a scalpel, either on the dorsum in the middle line, or below, through the floor, according to its position, and a further exploration made with a steel director in the hope of finding a circumscribed abscess. In the most severe cases, however, nothing of the kind is possible, and all that can be done is to make a free incision down the dorsum of the tongue on each side of the middle line about half an inch from it, and offer a chance of escape to the inflammatory effusion. The depth need not be great, but the submucous tissue should be opened up. Afterwards the patient usually requires a prolonged course of tonics. Acute glossitis rarely occurs except in those whose health is already broken down, and its course is so rapid and so severe that death may ensue simply from exhaustion. Tracheotomy may be required at any moment.

Simple Ulceration

This is usually caused by friction against the edge of a tooth or plate; but the liability to its occurrence and its severity depend very largely upon the state of health at the time.

The sore is generally situated at the side or under the tip; it may be single or multiple, according to the cause. When quite recent there is merely a superficial blister or excoriation, surrounded by a narrow zone of redness. In older cases and when the irritation is severe, it is more like a deep cut, extending into the substance of the tongue, with a sloughy surface and sharply defined angry edges. The dorsum near it is covered with fur; the mucous membrane around is swollen and œdematous, so that the sore appears raised above the level of the rest; the breath is offensive, and movement very painful. In very chronic ones the appearance is different again. The signs of acute irritation, the redness, swelling, and sloughing base are wanting; and in their place there is an amount of induration that suggests epithelioma at once. It is in these that Butlin's method of examining a scraping from the surface (if cocaine is used a considerable thickness is easily obtained) is chiefly useful, and it should always be tried when there is the least suspicion.

The diagnosis rests chiefly upon the position, the signs of inflammation, and the evidence of an exciting cause. If this can be found and removed, either by filing down or extracting a tooth, or by covering over a sharp projection with a shield of vulcanite, the irritated surface soon loses its redness and begins to granulate. Borax, chlorate of potash, and a lotion of chromic acid (gr. x. ad ℥j) are the most useful applications. If, however, the sore is indurated, in a person over forty years of age, and if improvement does not very soon take place, a further examination should be made, and unless it is perfectly satisfactory, there should be no hesitation in excising the whole affected area. Ulcers of this kind frequently leave fissured cicatrices extending some depth in the substance of the tongue.

Chronic Superficial Glossitis

The surface of the tongue is liable to a peculiar variety of inflammation which is of great importance, owing to its obstinacy and to the tendency to pass on to epithelioma. It is known by many names, and assumes many forms, but there is no evidence to show that there is any essential difference between them. A single patch is sometimes spoken of as *leucoma*; the term *chronic superficial glossitis* is usually reserved for that condition in which the whole surface is smooth and reddened, the papillæ having disappeared; when a large portion is covered with a thick milk-white mass of sodden epithelium, it is called *leucoplakia*; a very rare condition, in which the filiform papillæ, over more or less of the surface, are enormously hypertrophied, may, with some reservation, be spoken of as *ichthyosis* (it is not a congenital affection like true ichthyosis, but merely an inflamed papillomatous growth); psoriasis, tylosis, keratosis, and other similar expressions are not needed.

It is much more common in men than women, and rarely occurs under forty years of age. Tobacco-smoking, raw spirits, hot and irritating articles of diet, and syphilis are usually regarded as the causes, and there is no question that in the majority a perfectly definite history of one or all of these can be obtained; but it is equally true that it occurs sometimes in patients who have never suffered from syphilis and who have never smoked or drank to excess. In some the whole surface soon becomes involved, and these must be regarded as in some way specially predisposed to it; in others it remains limited to small patches for a great length of time, but it always begins opposite some irritant, either a tooth or the spot at which the end of a pipe rests. It is exceedingly common among dock-labourers at the East End, and I believe is due chiefly to smoking, and, very possibly, to the kind of tobacco.

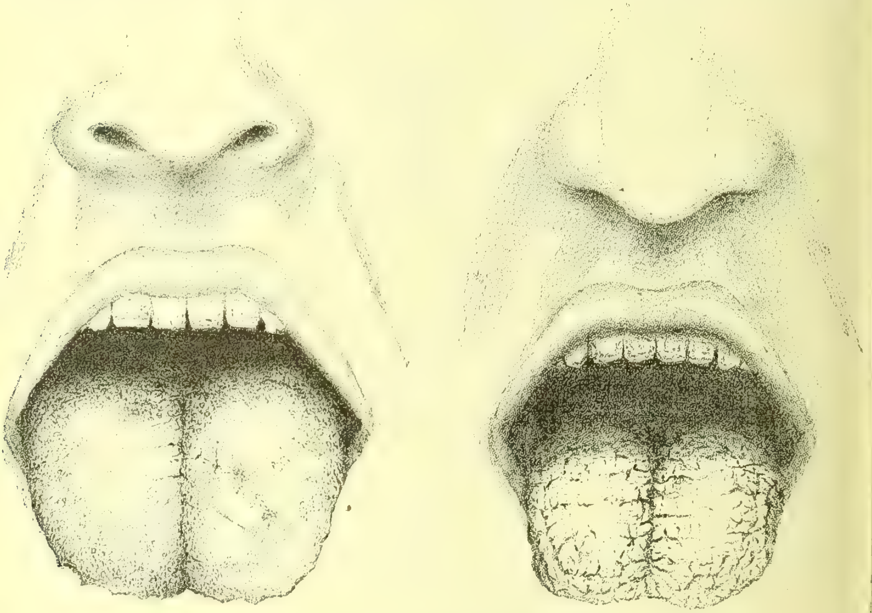

Fig. 324.—Chronic superficial glossitis.

1. The early stage, with slight enlargement.

2. The later stage, with dense coating of epithelium, cracked and fissured.

The appearances differ immensely in different stages. In the earliest, one or more spots upon the surface are smooth, glossy, and redder than the parts around. The mucous membrane is hyperæmic and œdematous, the horny layer of the epithelium is detached, and the natural inequalities of the surface are levelled up. The swelling is not noticeable unless a considerable portion of the tongue is involved; then the increase in size is shown by the deep depressions for the teeth all round the edge (fig. 324). By-and-by, as the epithelial layer continues to grow, bluish-white, semi-translucent patches make their appearance here and there; gradually these become thicker and more opaque in the centre, and spread farther and farther round the margin, until at length, if the irritation continues, the whole surface is covered over with a sodden layer like the epidermis of the hand after it has been poulticed. Before this stage is reached other changes begin. The dense covering of epithelium, like sodden wash-leather to look at, impedes the movements of the tongue; its flexibility is lost; often it shrinks in size and becomes hard and dense; deep cracks and fissures form, arranged longitudinally and transversely in a symmetrical pattern; and, after a while, as these become more and more worn, ulceration follows. In severe cases the inflammation is seldom limited to the tongue itself; not unfrequently the white patches extend over the floor of the mouth, and on to the lips and palate as well.

The ichthyotic variety is very rare in comparison. It originates as an inflammatory overgrowth of the papillæ at one or more points. They grow out and form rugged thorn-like masses covered with sodden layers of epithelium, but do not apparently infiltrate the deeper layers to the same extent. It usually occurs upon the tongue, but I have seen a typical example upon the inner surface of the upper lip caused by persistent smoking.

The symptoms of which the patient complains are very slight. There is a certain amount of discomfort, but it comes on so slowly that it is scarcely noticed. The tongue is tender; in the later stages it feels uncomfortable and stiff, and the sense of taste is impaired, but unless the surface becomes ulcerated opposite a tooth or deep down in one of the fissures, there is rarely any actual pain.

The prognosis, except in the slighter cases, is very unfavourable. Partly, no doubt, this arises from the fact that the same causes are usually allowed to continue at work, although, perhaps, with a less degree of intensity; but, independently of this, treatment has singularly little influence, if once the epithelium has definitely become opaque. What proportion of these cases end in carcinoma is very uncertain: according to Butlin, the number is probably under-estimated. Sometimes an ulcer or a fissure becomes the seat of malignant disease, the columns of epithelium growing down into the subjacent layers, as in other parts of the body; but not unfrequently it develops simultaneously over a large extent of surface in cases in which the leucomatous condition of the tongue has never been sufficiently marked to attract attention.

Treatment.—All sources of irritation should be removed at once; diet must be carefully regulated, and smoking prohibited; it is clearly impossible even to procure relief if the causes are allowed to continue. The rest is simply palliative. Mercury and iodide of potash very rarely effect any good. Local washes of bicarbonate of potash or borax are sometimes beneficial; in other cases chromic acid or dilute bicyanide of mercury painted over the surface once or twice a week answers better. Caustic should never be used, but localised indurated patches or obstinately persisting ulcers may sometimes be excised, even though there is at the time no evidence of malignant disease.

Syphilitic Affections of the Tongue

Primary chancre is very rare, but it may occur, usually near the tip. The induration is always well-marked, and this, together with the age of the patient, the rapid enlargement of the glands, and the influence of treatment, s the chief diagnostic feature.

Mucous patches are very common, and present immense variety. On the dorsum they form flattened elevations of a greyish-white colour, smooth or slightly papillated on the surface. There is no red areola surrounding them and they are not sensitive. Under the tongue they grow out into low, cauliflower-like projections. At the tip and margin where they are irritated by the teeth they develop into ulcers. Sometimes these are superficial, but often, if there is a ragged edge, they extend deeply into the mucous and submucous tissue, leaving irregular fissures and cicatrices when they heal. In many cases it is very difficult, if not impossible, to distinguish these from simple traumatic ulcers, except by their persistence, and by the slight degree of inflammation around them.

In the later stages syphilitic inflammation is almost as common. Sometimes it takes the form of a rounded gumma deep in the substance of the tongue, forming a soft ill-defined swelling, usually projecting on the dorsum in the middle line. This may be absorbed and disappear under treatment, leaving a buried cicatrix which, without implicating the surface, entirely destroys the shape; or it may break, like any other gumma, and form a sloughing cavity with overhanging ragged edges. In other cases the exudation is more diffused, and numerous small tubercles are developed one after the other, leaving irregular sores and radiating scars. Sometimes, again, hard patches make their appearance in the mucous and submucous tissue, and grow larger and larger until they form definite elevated plaques, the surface of which loses the papillæ, becomes dense and white and then breaks down into irregular ulcers and fissures; and occasionally what is known as sclerosing glossitis sets in; the substance of the tongue is infiltrated more or less throughout; the natural tissue-elements are destroyed, and an uneven, fissured, hardened, and distorted mass is left. As these different forms rarely or never occur by themselves, and as they are nearly always complicated by leucomatous patches and ulcers caused by the teeth, the ultimate result in a tongue affected by severe syphilis can hardly be described: the shape is altogether altered; few or none of the papillæ are left; deep fissures traverse the surface in all directions; hardened elevations, covered with dense white epithelium, project between; and ragged, irregular, and painful ulcers are scattered around the margins and at the bottom of the clefts.

Diagnosis.—The induration in syphilis is rarely so dense or so well-defined as in epithelioma. Other signs are of little value in comparison. Both diseases are common at the same time of life, although, of course, syphilis may occur earlier. If the sore is on the dorsum, if there is little pain on pressure and little salivation, it is probably due to syphilis; but it is impossible to say more, as one so often develops from the other. If there is the least doubt a scraping from the surface should be examined under the miscroscope. Iodide of potash not unfrequently causes a temporary improvement in typical malignant cases (possibly, because of the syphilitic foundation), and care must be taken not to be misled by this.

Treatment.—The constitutional treatment of syphilitic glossitis is most important; but at least as much care must be paid to local conditions. The mouth should be washed out frequently with a gargle of chlorate of potash and lotio nigra, or of very dilute bichloride of mercury. Obstinate patches should be painted over every day with chromic acid (gr. x. ad ℥j), or bicyanide of mercury (gr. xv. ad ℥j). Iodoform, if the patient can stand it, is especially valuable for deep ragged ulcers; but caustic, which stops almost immediately the progress of fissures at the angles of the mouth, should never be used in the case of the tongue. Smoking should be altogether left off; very great attention must be paid to diet; all hot or highly seasoned articles of food, and spirits, avoided; and the teeth carefully examined to make sure that no ragged corners project and irritate the surface.

Tubercular Disease

Tubercular ulceration of the tongue may occur either as a primary affection, or be secondary to similar disease in the lungs or larynx. The diagnosis in the early period is exceedingly difficult. The strongest family or personal history of one disorder does not exclude the possibility of another. It may occur at any age or in either sex, although it is more common, like most other affections of the tongue, in men. The tip or the dorsum is the part usually attacked first; minute semi-translucent vesicles appear in the mucous membrane; these grow larger and larger until they break, leaving shallow ulcers with slightly reddened edges. Then, by degrees, as the disease extends, fresh vesicles form around, and the ulcers grow deeper and deeper, until at length they develop into ragged excavations, with pale, flabby sides and bases. There is no induration, and this, with the age of the patient, the history, and the evidence of tubercle, either in the tissues around or in other organs, is the chief feature distinguishing it from epithelioma. The pain at first is not severe, but later, when the ulceration extends to the deeper parts, it often becomes extreme, and, by preventing the patient taking food, materially hastens the progress of the disease.

The prognosis, especially when the affection is secondary to disease of the lungs or larynx, is exceedingly bad: it nearly always indicates rapid extension. Primary tubercular ulceration is more susceptible of treatment. Excision is sometimes possible, the wound healing readily; if this cannot be effected, an attempt may be made to destroy the surface of the sore by free scraping and the actual cautery; but if this is done it must be thorough, half-measures are worse than useless. Lactic acid has been strongly recommended, but the application is very painful. In more advanced cases, iodoform with borax and a minute quantity of morphia may be dusted on by means of an insufflator. Constitutional treatment, cod-liver oil, iron, and nourishing diet, are of course absolutely essential: and every care must be taken to protect the tongue from sharp or rough edges of teeth, and from irritation by hot or stimulating articles of diet. Finally, when the pain and salivation can no longer be controlled by other measures, a certain amount of relief is obtained by division or resection of the lingual nerve.

Lupus sometimes extends to the tongue, causing a form of ulceration which can hardly be distinguished from this, and occasionally other varieties of inflammation occur, due to persistent dyspepsia, gout, and (very seldom at the present day) mercury.

TUMOURS OF THE TONGUE

Nævus forms a smooth, soft, lobulated swelling, usually of a purplish-red colour, with a few brighter points upon it. It can be recognised at once by the way in which it disappears on pressure and slowly fills again, but it rarely attracts much notice unless it gets in the way of the teeth; then it may lead to serious hæmorrhage. Sometimes it degenerates, leaving a warty growth upon the surface. If it persists or continues to grow, it can be cured by a single application of the cautery. A similar dilatation of the lymphatics is sometimes seen.

Dermoid cysts occasionally develop in the tongue; probably, as they are nearly always in the middle line, from the hyolingual canal. *Mucous cysts*, similar to those found on the lips and cheek, may occur, especially on the dorsum. Hydatid cysts, blood cysts, and other varieties are very rare. *Chronic abscess*, which in many respects closely resembles a cyst, is not so uncommon.

Papillomata are frequent at all ages. They are distinguished from epithelioma by the absence of induration, but great care is required in the case of people over forty years of age. If there is the least suspicion, very free removal of the base, as well as of the growth, is advisable. Sometimes dendritic condylomata resemble them very closely.

Lipomata and fibromata, probably of congenital origin, are occasionally met with, growing out in a polypoid form, and one or two cases of sarcoma and adenoma are on record; but all these are very exceptional.

Squamous epithelioma, on the other hand, is exceedingly common, especially between the ages of forty and fifty-five. Before thirty it is very rare, and, in comparison, it is seldom met with in women.

The immediate cause is unknown, although there is no question that it is in some way the outcome of persistent irritation. Smoking and dram-drinking undoubtedly assist in its production; in a very large proportion of cases it begins in an old leucomatous patch, an irritated papilloma, or a chronic ulcer on the side of the tongue; syphilis predisposes to it by the sores and scars that it leaves behind; it is not uncommon for it to develop at the seat of an old gumma, or even directly from a syphilitic ulcer; but not one of these things, nor all of them together, offers a satisfactory explanation for its growth. It may spring from any ulcer, however caused, from any scar, or any part of the tongue that is irritated, whether by a tooth or by caustic, and even in some cases apparently from a healthy surface.

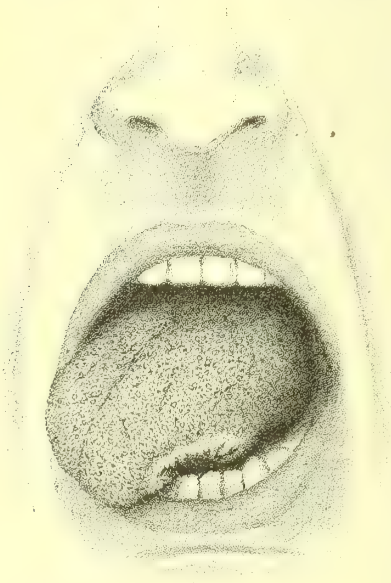

FIG. 325.—Epithelioma of the tongue.

Its first appearance is equally variable, depending upon the condition of the spot at which it grows. There may be merely a little induration at the base of a papilloma or under the floor of an ulcer or fissure; a leucomatous patch may insidiously become thick and dense, or a nodule may form quietly without being noticed in the substance of the mucous membrane. Naturally, from the causes that predispose to its occurrence, it is more common on the edges and at the tip; but no part is exempt. However it forms, when it is first seen it usually has already assumed the shape of an ulcer; the epithelial surface has broken down, and an uneven, ragged sore with a sloughing base, is already developed. The only constant feature is the induration due to the accumulation of the epithelial growth.

The edges are irregular, raised above the surrounding part, and intensely hard; the base may be covered with warty granulations, may even not be ulcerated at all (when, for example, it originates from a papilloma or a superficial leucoma), but it is always hard. Induration, in short, is the distinctive feature of the disease; the only other affection that resembles it is a primary chancre, and that is very rare in comparison; and it is so marked a characteristic that any sore or warty growth in a person over forty years of age, that presents it in the least degree, should be regarded as exceedingly suspicious. It may be scraped and examined, or it may be excised at once, but under no circumstances should it be allowed more than a fortnight's grace.

Pain may be present from the first; in the later stages it is never absent, radiating into the ear and over the whole side of the face. Salivation is of frequent occurrence and very distressing, from the movement of the tongue it occasions. The glands become enlarged exceedingly soon, nearly always within the first three months, sometimes even earlier. Sooner or later, according to the position of the growth, the disease extends to the floor of the mouth or along the arches of the palate to the tonsil; the tongue becomes fixed, and even the bone at length involved. When this stage is reached, the suffering becomes intense; speech and swallowing are almost impossible; the pain never ceases; salivation is profuse; the mouth is filled with a foul sloughing ulcer, and the strength fails rapidly. Death usually takes place in a year or eighteen months. The constant pain, the want of food and sleep, the hæmorrhage from the ulcers in the floor of the mouth, and the suppuration and sloughing speedily bring on the most profound exhaustion. Sometimes this alone is sufficient; in other cases the immediate cause is an attack of bleeding rather worse than usual, or what is more common still, septic pneumonia, due to the inhalation of particles from the foul and putrid surface. It is noteworthy that secondary deposits, other than those in the glands and floor of the mouth, are not so common in this variety of carcinoma as in many others.

The diagnosis in the early stages is often very difficult. Papillomata, syphilitic and tubercular ulcers, and those due to chronic irritation, all bear a close resemblance to carcinoma, and not unfrequently pass into it; while it must be always remembered that the clearest evidence of syphilis does not preclude in the least the presence of carcinoma too; some would even go so far as to say that it is actually in favour of it. If there is the slightest induration, a scraping should be examined, and unless the absence of epithelioma is proved the sore should be excised. Small operations of this kind are not in any way serious, while the risk on the other side is fearful. As already mentioned, no reliance can be placed on temporary improvement under the influence of iodide of potash.

Treatment.—Early removal is at present the only hope of cure. It is true that the percentage of cases that have lived for more than a year without recurrence is very small, but when it is recollected that hospital patients (and many private ones) often do not apply for treatment until months have passed, and that then they frequently will not submit to operation until some other remedy has been tried and failed, the blame should not be laid upon the operation. It is certain that in cases of early and thorough removal, not only is the immediate mortality very much less, but the period of immunity very much longer.

When, owing to the position or extent of the growth, there is no chance of complete removal, or when the carcinoma has returned, much can still be done to relieve suffering. Excision of the growth is certainly justifiable if it offers a hope of relief from pain; the stump of the tongue sometimes remains healthy, even when the operation is too late to intercept the glandular enlargement. In exceptional cases parts of the surface may be destroyed with the actual cautery, if only the painful spot is limited in extent; but discretion must be used, as ineffectual cauterisation only makes the growth tenfold more rapid. The lingual nerve may be divided; this nearly always stops the pain and salivation at once, although, unless a portion is resected, the benefit is only for a time. In most cases, however, especially towards the end, morphia is absolutely necessary, and if it is given it should be given freely. Butlin recommends dusting the surface with a powder composed of iodoform, borax, and morphia.

The fœtor, which is very distressing, must be checked with iodoform, or washes of permanganate of potash, dilute carbolic acid, or other antiseptics. A small quantity of cocaine may be added if the smarting is severe. Inhalations of eucalyptus and creasote are also very useful. If there is any hæmorrhage it must be checked by local pressure, ice, or the application of styptics. The feeding of patients suffering from epithelioma of the tongue in its advanced stages is always difficult. Mastication is impossible; the pain is so intense when anything touches the tongue that deglutition can hardly be carried out; and later the larynx is often insufficiently protected. So long as swallowing is possible the food should be carefully prepared beforehand; but in many cases the patients after a little while prefer to feed themselves by means of a funnel and soft rubber tube. Towards the end even this may be impossible, and it may be necessary either to pass a tube through the nostril or make use of nutrient enemata.

OPERATIONS UPON THE TONGUE

Removal of the tongue may be accomplished through the mouth, with or without previous division of the cheek; or through the floor after a varying amount of dissection. Division of the jaw itself adds very greatly to the gravity of the operation, without—unless the disease has involved the bone—any commensurate advantage.

The choice of operation is naturally influenced chiefly by the seat of disease. If the growth is very recent, little more than a suspicious papilloma, and near the tip, a very small operation through the mouth may suffice. If it is more advanced, the whole tongue can be removed without external incision; but if either of the glands is involved, or it is thought (and there can be little doubt about it) that the patient stands a better chance by removing not only the tongue itself but the lymphatic tissues in the floor of the mouth, a submaxillary incision is essential. Removal of the anterior half is not necessarily a serious operation: removal of the whole, whether through the mouth or by means of a submaxillary incision, undoubtedly is, but there is no evidence that the latter of these two methods is worse than the former. An incision through the cheek is only required when the growth extends down the side of the tongue in that direction.

The chief dangers attendant on removal are: *hæmorrhage* from the lingual arteries, weakening the patient at the time and causing broncho-pneumonia later; *asphyxia*, from blood trickling into the lungs, acute œdema of the larynx, or falling back of the stump when the muscles that attach the tongue to the symphysis are divided; and especially *broncho-pneumonia*. This, which is by far the most frequent cause of death, is the result of blood, particles of food, or septic material from the foul and sloughing surface finding their way down the trachea. Sometimes there is gangrene of the lung; more frequently minute scattered points of consolidation, which do not give rise to any physical signs, but which can be diagnosed with almost as great certainty from the aspect of the patient. There may be no rise of temperature, no pain, and scarcely any cough: but the patient does not seem to rally; the face is dusky and pinched; the eyes surrounded by dark rings; the pulse quick and very small; and the respiration hurried and shallow. If it occurs it is practically fatal; but a very great deal may be done in the way of prevention by selecting suitable methods of operation, and by careful after-treatment.

1. Removal without an External Incision

This may be accomplished either with scissors (Whitehead's method) or with an écraseur (Morrant Baker's); the galvano-cautery is practically abandoned, owing to the extensive sloughing it causes.

(*a*) The scissors used by Whitehead are flat and straight, sharp up to the tips, which are square and blunted. The patient is placed under an anæsthetic in the position that will secure the best light; chloroform is usually preferred, given by means of a rubber ball syringe; but even more than the usual amount of caution is necessary, and unless a preliminary laryngotomy is performed, the administrator must watch with the greatest care that no blood trickles down into the trachea. The hands may be fastened to the side, but nothing should pass round the chest; and the body should not be fastened to the operating table, as it may be necessary at any moment to roll the patient over on to his side and syringe out the mouth in order to free it from blood.

As soon as the patient is anæsthetised, Coleman's or Mason's gag is placed between the teeth on the side opposite to the operator, and entrusted to an assistant, who attends to this and to the sponging. The lips can be drawn out of the way with retractors fastened to an elastic band, if it is considered necessary. A double silk ligature is then passed well through the substance of the tongue and given to a second assistant.

The operator begins by cutting the mucous membrane that extends from the tongue to the alveolar process, keeping close to the bone. The anterior pillar of the fauces and the structures that attach the tongue to the jaw come next, the assistant meanwhile keeping the tongue well forward; then the muscles that form the base are cut across by a series of successive snips until the entire structure is separated on the plane of the inferior border of the lower jaw, and as far back as the safety of the epiglottis permits. The arteries are tied or twisted as they are divided, and a ligature passed through the remains of the glosso-epiglottic fold to draw the stump forwards, in case of secondary hæmorrhage.

Whitehead has never found any difficulty in securing the arteries. If there is any bleeding it can be controlled at once by passing the finger behind the root of the tongue, drawing it forwards and pressing it towards the opposite side, as Heath recommends. Jacobson, with the view of avoiding it, merely cuts a deep groove through the mucous membrane on the side and dorsum, and then tears the soft muscular tissues with closed scissors until the artery and nerve are seen. Bilbroth ties the linguals first, but those who have followed out Whitehead's directions generally consider it unnecessary.

(*b*) When the écraseur is used the preliminary steps are the same, but two ligatures are passed through the tongue, one through each half, and the whole organ divided down the median septum. If the dorsum and tip are cut fairly deeply with a straight blunt-pointed bistoury, the two halves can be separated from each other with the forefingers without causing any material hæmorrhage. The mucous membrane and the muscles passing from the jaw to the tongue are divided as before; and then, as soon as the two halves are thoroughly freed as far back as is considered advisable, a loop of stout whip-cord attached to an écraseur is passed over each. The section should be from the middle line outwards, and the loop may be tightened fairly quickly at first, but as soon as any resistance is felt not more than one turn should be made in the minute. Very frequently the vessels, with, perhaps, the nerve, are dragged out in a long loop, when they can be easily secured and tied.

If the whole of the structures that attach the tongue to the jaw have been divided, it is advisable to fasten the stump to the mucous membrane at the side of the mouth by means of sutures, for fear of its falling back.

It is very difficult to estimate the relative advantages of these methods, as they both require a considerable degree of skill, and operators are naturally inclined to that which they have practised most. Morrant Baker's is the easier, and if the écraseur is only used slowly is practically exempt from bleeding. On the other hand, it tends to make the stump convex, although this is concealed by the muscular contraction, and it is probable that the amount of bruising is greater. Certainly this was the case with the old chain écraseur. Contrasted with this, the scissors are sometimes followed by serious hæmorrhage, but the operator can see the whole time what he is doing.

It is still an open question whether it is ever advisable to leave half the tongue. In most instances it bends round upon itself, owing to the contraction of the cicatrix, and only becomes an incumbrance; but occasionally it moulds itself into shape and assists both in speaking and swallowing.

Preliminary laryngotomy is advocated by many, and no doubt possesses great advantages, with slight, if any, additional risk. The fauces can be plugged so that no blood can possibly pass down; the administration of the anæsthetic is easier; the mouth can be sponged freely if there is any bleeding; and the operator can proceed quietly and deliberately. As Jacobson points out, when scissors are used the amount of swelling and inflammation after the operation is so slight that there is no need to retain the cannula after the patient has rallied from the anæsthetic.

If any glands require removal, or if there is any infiltration in the floor of the mouth, a separate incision is advisable. The dissection in such cases must necessarily be very thorough if it is attempted.

2. Removal by Sub-maxillary Incision

Of these, by far the best is that devised by Kocher, who performs it under the carbolic spray.

A preliminary tracheotomy is performed and an ordinary cannula inserted. Entry of blood is prevented by plugging the pharynx with a sponge soaked in carbolic acid. The incision runs along the anterior border of the sterno-mastoid from the ear nearly down to the middle of the muscle; from this it turns forwards to the hyoid bone and along the anterior border of the digastric to the symphysis. A flap, containing skin, platysma, and fascia, is reflected upwards; the facial artery and vein tied; the lingual secured on the hyoglossus; and the sub-maxillary fossa completely cleared out, beginning from behind. All the cellular tissue is removed, together with the lymphatic glands, and the submaxillary and sublingual ones if they appear involved. The mylo-hyoid muscle is then separated, the mucous membrane divided, and the tongue drawn through the opening. If the whole thickness is removed the opposite lingual must be tied as well.

Before commencing the operation the mouth and the nasal cavities are thoroughly washed out with a solution of perchloride of mercury (1 in 2,000); and after it is finished and the wound adjusted with sutures the surface of the stump and the pharynx behind it are covered over completely with a sponge soaked with carbolic acid. The dressings are changed twice a day, advantage being taken of the opportunity to pass an œsophageal tube and feed the patient; for the rest nutrient enemata are used. The operation is undoubtedly more extensive than the others, but it is believed that this is amply compensated for by the thoroughness with which the whole of the affected tissues is removed and the way in which the risk of septic inflammation and pulmonary complications is avoided. Kocher himself has been very successful as regards immediate mortality, but the operation does not seem to have been performed by other surgeons to any great extent.

The after-treatment of these cases requires even more than ordinary care. Every endeavour must be used to prevent putrefaction, which, owing to the temperature, moisture, and alkaline reaction, is very prone to follow; the patient's strength must be husbanded and maintained in every way; and precautions taken to prevent food or the discharge from the wound entering the lungs. With this in view, Kocher fills the entire cavity, from the edge of the wound back into the mouth and pharynx, with a sponge soaked in carbolic acid solution, shutting off the nasopharyngeal cavity on the one hand and the larynx and pharynx on the other. The same object may, however, be achieved much more satisfactorily by means of a plan recommended by Barker. The whole wound is carefully cleansed, dried, and dusted with iodoform, and the two ends of the incision sutured. In the middle a piece of rubber tubing is adjusted, long enough to reach well down into the œsophagus; and all the space around is carefully packed with antiseptic wool. This can be left untouched for days, the patient being easily fed by means of a funnel as often as may be required.

The ordinary practice, when the tongue is removed through the mouth, is either to wash the cavity out at frequent intervals with a dilute antiseptic, or to keep the surface of the wound as dry as possible by means of iodoform. Drainage is not very successful; a large tube may be passed through the floor of the mouth and fixed at the proper level, but it is of little use except to secure a thorough flow of the antiseptic across the surface of the wound. If the first method is preferred it is a wise precaution to make the patient practise washing out the mouth beforehand, as there is sure to be a certain amount of awkwardness at first. Immediately after the operation the surface of the wound is brushed over with chloride of zinc, or better, with Whitehead's varnish (Friar's balsam, in which a saturated solution of iodoform in ether has been substituted for rectified spirit), and as soon as the effects of the anæsthetic have thoroughly passed off and the patient has rallied, the mouth is washed out at frequent intervals with a dilute solution of carbolic acid or permanganate of potash, the head being held on one side so that none of the discharge is swallowed. In addition, the surface of the wound may be brushed over four or five times a day with a solution of iodoform, or the patient may inhale eucalyptus vapour or some other volatile antiseptic.

In most cases, however, there is no difficulty in keeping the surface of the wound dry. The simplest method is, at the time of the operation, to fill the cavity with iodoform (after sponging it out) and rub it well into the surface, or to use Whitehead's varnish. The more scientific plan is to prepare some gauze with iodoform (by means of glycerine and colophony dissolved in alcohol), cut it into strips, and pack the whole cavity with these, laying them flat, one upon the other, with fresh iodoform between until the wound is filled. The deeper layers adhere to the raw surface, from which they cannot be separated until it has begun to granulate; the superficial ones, sodden with saliva, may be removed and renewed from time to time. At the end of a few days the whole comes away of itself, leaving a healing surface beneath. Even this, however, will not altogether prevent septic pneumonia. Probably, in those whose tissues are healthy and well-nourished, either of these plans would succeed; the wound in the floor of the mouth would not slough to any extent and the lungs would be able to resist infection. In those, on the other hand, who are already broken down by exhaustion, privation, consciousness of the presence of cancer, and perhaps past intemperance, it is almost impossible to prevent sloughing.

The general treatment requires an equal amount of care. Speaking must be prohibited; all food given, either by means of a soft rubber tube and funnel through the mouth (it is as well that the patient should have practised this beforehand), or for the first few days by the rectum; stimulants in moderation are nearly always beneficial; and of course all food must be liquid. It is not advisable to relax a single precaution until the surface of the wound has begun to clean. The patient should be encouraged to sit up in bed as soon as he can, on the second day if possible; but care must be taken to keep him warm and to avoid anything of the nature of a draught.

OPERATIONS ON THE LINGUAL NERVES

The lingual nerve may be stretched, divided, or resected to relieve the pain and salivation in carcinoma, and for neuralgia of the tongue. Of these operations, the first has not been performed a sufficient number of times to enable an opinion to be formed as to its value; the second is of undoubted service, but only for a short time: in a month or so sensation begins to return, and pain with it; the third is more hopeful.

The patient is placed under an anæsthetic, and the tongue forcibly pulled out of the mouth with a broad pair of tongue-forceps, towards the opposite side. When this is done the lingual nerve stands out beneath the mucous membrane as a tense band, stretching from the margin of the internal pterygoid to the side of the tongue. A sharp-pointed hook can then be placed beneath it, the tension on the tongue relaxed, and the mucous membrane over the nerve divided sufficiently to enable it to be seen and isolated. The longer the portion that is removed the better.

Section is easily performed by what is known as Moore's method. An incision about three-quarters of an inch in length is made through the mucous membrane in a line from the last molar tooth to the angle of the jaw. The finger is passed down to the bulging alveolar border to act as a guide; a curved bistoury is used so as to get in under the projection; and everything is divided down to the bone.

DISEASES OF THE TONSILS

The tonsils lie between the pillars of the fauces covered with mucous membrane. Immediately outside is the superior constrictor of the pharynx, by which they are separated from the internal carotid and ascending pharyngeal arteries. Of these the former lies about half an inch behind and to the outer side; but, if it is thrown into curves, it may approach nearer. The latter appears insignificant; but, if wounded, the hæmorrhage is scarcely less serious.

Inflammation

(*a*) *Simple catarrhal or erythematous tonsillitis* sometimes occurs by itself, caused by fatigue or exposure to cold and wet; but much more often it is merely part, and the most insignificant part, of a general disorder, such as acute rheumatic fever, scarlatina, or septicæmia induced by the inhalation of foul air or sewer gas. The symptoms under these circumstances naturally present no sort of relation to the affection of the throat; there may be a rigor with very high temperature as in scarlatina, or, on the other hand, the most profound depression, so as to suggest typhoid, as in poisoning by foul air; nor is there anything in the throat itself by which one condition can be diagnosed from the other. The surface is reddened; there is a slight amount of swelling involving the soft palate and fauces as well as the tonsil; the throat feels hot and dry; often there is a tickling or aching sensation in the ear; hearing is impaired; swallowing painful; and in severe cases there is tenderness on pressure behind the angles of the jaw. If the inflammation continues, the swelling becomes more and more prominent: white specks formed of sodden epithelium mixed with mucus and leptothrix filaments make their appearance in the depressions of the gland, and the follicles themselves become involved.

(*b*) *Follicular tonsillitis* may be acute from the beginning, when for example, it results from catarrhal inflammation; but more frequently it is chronic and persistent, varied every now and then by acute or subacute attacks. The swelling involves the gland only; the mucous membrane around is but slightly affected; the surface is very uneven; all the crypts and depressions are filled with drops of muco-pus, and when these are detached or squeezed out funnel-shaped ulcers are left. The readiness with which inflammation breaks out and the persistent tendency to sore-throat in those who suffer from this condition may be traced to the presence of these foul decomposing masses of epithelial débris, mucus, fragments of food, and leptothrix filaments. Each one acts as a source of infection for all the structures around, giving rise to an acute attack if, from any cause, there is the least hyperæmia or abrasion of the epithelium.

(*c*) *Hypertrophy of the tonsils.*—Chronic enlargement of the tonsils is especially prone to occur in children, owing in part to the much greater activity of the lymphatic tissue in the early years of life, and in many cases is associated with a similar enlargement of the submaxillary glands. Practically, it is the outcome of constant irritation, not sufficiently severe to cause either catarrhal or follicular inflammation, though these are often present as complications, and it affects especially the adenoid tissue. It is always bilateral, though very often one is considerably larger than the other.

If the tonsils are not inflamed, the surface is pale and smooth, or reticulated, from the widely stretched orifices of the crypts, which are much more shallow than natural; but often they are reddened, congested, and, if there is any inflammation of the follicles, dotted all over with yellowish-white patches, each of which is surrounded by a brighter ring. There is little or no pain, unless the inflammation is acute, and no fever; but the voice is altered, assuming a nasal tone; respiration is interfered with, so that, particularly in rickety children, the chest falls in and becomes pigeon-breasted; hearing is impaired; the child is compelled to breathe through its mouth, and snores at night; the aspect becomes stupid and vacant; active exercise is rendered difficult; the blood is imperfectly aërated, and the general nutrition is seriously affected. Very often attacks of subacute or follicular tonsillitis occur as well, this condition apparently acting as a predisposing cause; and then the enlargement may become serious, and cause attacks of very alarming suffocating spasm at night.

(*d*) *Acute suppurative tonsillitis, or quinsy*, either commences in the tonsil itself, when, as a rule, there are a number of small abscesses side by side, and the symptoms are not of the most severe type, or in the cellular tissue around the gland. It appears to be due to the same causes as follicular and erythematous tonsillitis, acting with greater intensity, or affecting those who are broken down in health by over-work or other troubles. The periglandular form is practically confined to adult life, and has a marked tendency to return at distant intervals. Sometimes it affects the retropharyngeal tissue rather than the neighbourhood of the tonsil itself, and it is distinguished by the way in which the tonsil is concealed from view; the arch of the palate is enormously swollen; the mucous membrane covering the anterior pillar of the fauces and the side of the tongue and mouth is a dusky red; the glands under the jaw are enlarged, and, in the worst cases, the loose cellular tissue that extends between the jaws and fills up the side of the neck and the floor of the mouth is involved as well, so that a huge swelling forms all over that side of the face, and the teeth cannot be separated from each other even to allow the tip of the tongue to protrude. Fortunately, this very severe form seldom affects the two sides at the same time, and suppuration rarely occurs in both. The onset is sudden, with a succession of severe chills, and the temperature may rise to 103° or 104° F. From the first there is unusual depression and anxiety; the pain is very severe, especially in the ear, but radiating all over the face; salivation is often profuse, and there is a constant secretion of viscid mucus at the back of the throat, causing great distress by exciting reflex movements of deglutition. Breathing is difficult, swallowing almost impossible; the jaws are rigidly fixed, partly from the pain, partly owing to reflex muscular contraction; and, as pus begins to form, the throbbing becomes almost unbearable. In the slighter cases—those which affect the tonsil itself—a number of minute abscesses are usually present, and break one by one into the interior of the mouth; in the more severe ones, when there is acute periglandular inflammation, the pus may burst in the same direction at the end of the fifth or sixth day, giving great and immediate relief; or it may work its way into the soft palate, or even sometimes down into the neck, before it can be evacuated. Even when the attack has been of short duration it always leaves a condition of serious debility.

Treatment.—The constitutional treatment of acute tonsillitis depends naturally upon the disorder with which it is associated. If none can be found, all that can be done is to meet the symptoms as they arise, giving quinine, salicylate of soda, or antipyrin when the temperature is high; and tonics, and especially iron, after the acute stage has subsided. Chronic hypertrophy, on the other hand, is nearly always associated with that peculiar susceptibility to inflammation which finds its highest development in what is known as scrofula, and must be met from the first with tonics, iron, cod-liver oil, good food, and sea air.

The local treatment must be guided by the severity of the attack. In the milder forms which are frequently associated with a relaxed condition of the mucous membrane of the palate and uvula, astringent gargles (of alum, bichloride of mercury with decoction of cinchona, &c.) are sufficient. In more severe cases, in which there are numerous points of follicular inflammation, the accumulated débris may be removed by washing out the mouth with hot salt and water, and then the surface thoroughly brushed with nitrate of silver (gr. xx. ad ℥j), glycerine and tannic acid, or glycerine and perchloride of iron. Much of the discomfort of this proceeding may be removed by using a solution of cocaine first; but even then in children it is often a matter of great difficulty. Sometimes a hand spray may be used, or creasote vapour inhaled from hot water, but these remedies are chiefly beneficial from a preventive point of view.

In chronic hypertrophy, when there is a mass projecting inwards behind the anterior pillar of the fauces, nothing but excision is of any avail; and the same treatment should be recommended for those cases of follicular tonsillitis in which the patient is constantly suffering from recurrent attacks, occasioned by the retention of the decomposing discharge on the surface of the gland. Moreover, it seems probable that tonsils affected in this way are more prone to be attacked by diphtheria than others, the membrane beginning in the crypts and growing out from them over the epithelial surface; and this alone would be a most efficient reason.

As an alternative the application of the galvano-cautery is sometimes made use of. The throat must be thoroughly pencilled with cocaine, and the burner applied while cold to the surface of the gland; the current is then turned on and a sufficient amount of tissue destroyed to make sure of a smooth dense cicatrix when the wound heals. The pain is said to be slight, and to be relieved by sucking small fragments of ice for an hour or two afterwards.

Acute phlegmonous inflammation requires more vigorous measures. An attempt may be made to cut the attack short at its onset by giving aconite (ɱj every half-hour) until there is a distinct effect upon the pulse; but it rarely succeeds. The bowels should be opened freely, while the patient can still swallow without much difficulty; ice placed around the neck, small fragments kept in the mouth; the patient induced to take as much liquid food as he can; and the surface of the swelling explored with the finger, cocaine being used freely both to relieve the pain, so that the patient may be able to open his mouth, and to prevent the spasmodic contraction of the muscles of deglutition, produced by touching the surface. If any spot can be found that is softer or more yielding than the rest, a puncture should be made in it with a bistoury, the blade of which is protected up to within an inch of the point by means of strapping wrapped round it. The tongue must be held down out of the way; the edge of the blade must point upwards and inwards, and the puncture made just through the margin of the anterior pillar (which is forced prominently into the mouth), perfectly straight from before backwards.

Excision of the tonsil may be performed with a bistoury, but it is much more satisfactory to employ a tonsillotome or guillotine. The simplest consists merely of a ring to slip over the projection, with, on its inner margin, a groove carrying a blade. Both ring and blade are on the same handle, one gliding on the other. A more complicated one carries a forked spear as well: this, by means of a spring, transfixes the growth and draws it slightly inwards towards the middle line, making it secure, and ensuring sufficient being taken away. The assistant stands behind the patient, holding the head so that the light falls into the mouth, and pressing with his fingers just behind the angles of the jaws in order to steady the tonsils. An anæsthetic may be used, but even in children cocaine is sufficient. The operator stands in front, and it is of great advantage to him if he can use his two hands equally well. As much of the growth as projects beyond the pillar of the fauces should be removed, for although the cicatrix contracts to some slight degree, it really produces very little effect if the gland contains much soft adenoid tissue. When, owing to the frequency of follicular inflammation, it is denser and more fibrous, there is less probability of the growth recommencing. Both tonsils should, if they require it, be removed at the same sitting; the pain and inconvenience are not materially greater than when one is taken away, and the cure is effected in half the time.

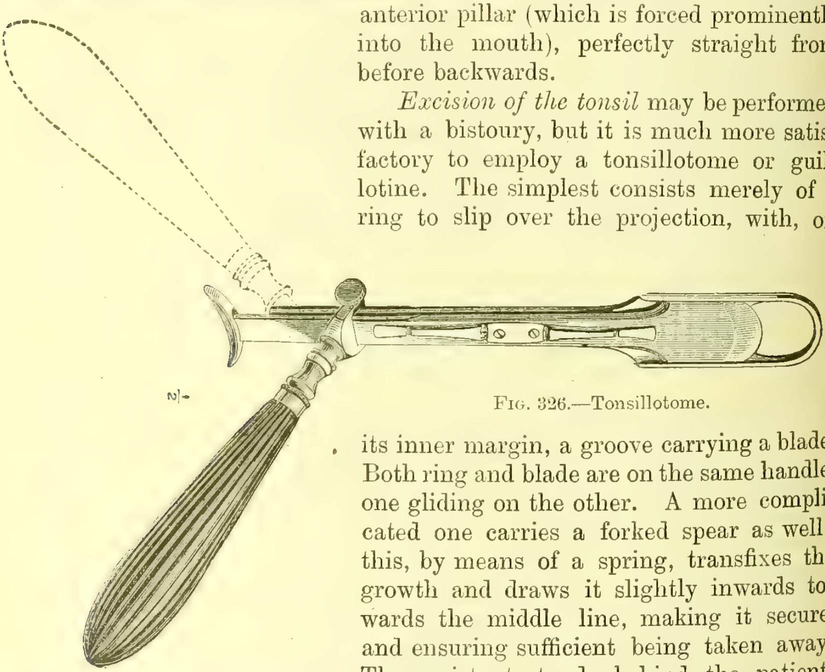

Fig. 326.—Tonsillotome.

Hæmorrhage that does not stop on the application of ice is very rare. If capillary oozing continues to any serious extent, perchloride of iron or some other styptic must be employed. It has, however, been necessary to tie the common carotid.

In addition to these the tonsil is liable to be attacked by various forms of specific inflammation. *Diphtheria*, for example, not unfrequently begins upon the tonsil, starting from an apparently simple attack of follicular tonsillitis and spreading thence to the mucous membranes around. *Scarlatinal ulceration* may occur, and open up the internal carotid by the sloughing it causes. The same thing may happen in severe cases of blood-poisoning, such as result from the inhalation of sewer gas. *Syphilis* very often attacks them; there are very few cases of primary chancre, it is true, but a peculiar circular and sometimes punched-out ulcer is nearly invariable in the early secondary stage, and very extensive ulceration may occur at a later period, destroying the soft palate and the pillars of the fauces, and dragging the base of the tongue backwards by the cicatrisation it entails. *Tubercular disease* is more rare, and in the earlier stages is difficult of diagnosis; later, when the ulceration becomes general, it is scarcely possible to tell in what part the disease began.

Tonsillar calculi are not uncommon, caused in all probability by the gradual inspissation of the masses of muco-pus that are found buried in some of the follicles. In composition they resemble the tartar that collects upon the teeth, and they may reach the size of a pea or small bean.

The only tumours that occur with any frequency are epithelioma and lymphosarcoma, and even they are not common. The former is nearly always secondary, originating in the structures near and gradually extending into it; the latter is primary, but very little can be done for either. Sarcomatous growths have been shelled out after ligature of the carotid, with success so far as the immediate result of the operation was concerned; but very rapid recurrence took place in all.

DISEASES OF THE SALIVARY GLANDS

Inflammation

The parotid suffers the most often of the three: the sublingual the least.

Acute parotitis is well known from its occurrence in connection with mumps. It may, however, be caused in many other ways. In some epidemics of typhoid fever, for example, it is fairly common: in others it is very rare. In pyæmia it is often met with; not unfrequently, even when there is no suspicion of this, it follows operations on the abdominal viscera; and occasionally it is due to ptyalism, the passage of foreign bodies up the duct, syphilis, tubercle, and other disorders.

In mumps suppuration is rare. The gland on one side suddenly becomes tense and swollen, assuming a characteristic shape, and causing very severe pain, especially when an attempt is made to open the mouth; and then, when it is beginning to subside, the opposite one usually behaves in the same way. Sometimes the submaxillary gland is affected, together with or independently of the parotid. Metastatic inflammation of the testicle is not by any means uncommon, and is of some importance, as it may end in atrophy. The ovaries and the meninges of the brain are also stated to be occasionally attacked, but this is much more rare. In the other varieties of parotitis, suppuration is of frequent occurrence and is often attended with high fever, owing to the tension of the fascia that surrounds the gland. The pus has been known to work its way into the ear and discharge through the external auditory meatus; to descend under the deep fascia of the neck; and even to track upwards along the course of the nerves into the base of the skull and set up acute suppurative meningitis.

In front of the ear over the parotid there is a small group of lymphatic glands which occasionally enlarge and become inflamed, and there are others in the interior as well; but the shape of the swelling is so different that there is very little risk of their being mistaken.

The treatment presents nothing special. Suppuration is hard to detect until the collection has attained a considerable size, owing to the dense fascia over the gland; but sometimes it is indicated by local œdema or by the presence of one especially tender spot. A grooved needle should be used for exploration, and if any pus is found the abscess should be opened after Hilton's method, as it is impossible to say, under such conditions, in what direction the very important structures that lie in the gland are displaced.

SALIVARY CALCULI

Calculi, composed of phosphate and carbonate of lime with magnesia and a proportion of animal matter, are sometimes met with in the duct of the submaxillary gland, and much more rarely in that of the parotid. The usual size is about that of a date-stone; small ones are passed occasionally, and very large ones, the size of a pigeon's egg, have been recorded. In most cases they do not give rise to symptoms of any kind unless the duct is blocked: then the gland enlarges and becomes distended until it is able to overcome the resistance in front and relieve itself for the time. Occasionally, however, they cause considerable inflammation and lead to the formation of a mass of dense inflammatory deposit extending through the whole sub-maxillary region. The nature of the trouble is usually detected at once by examination with one finger in the mouth and another under the chin, or by passing a probe down the duct. A free incision should be made through the mucous membrane so as to release it without breaking it; if this occurs the removal of all the fragments is sometimes very tedious.

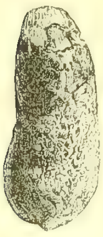

FIG. 327.—Salivary calculus, weighing 48 grains.

TUMOURS

The parotid gland is occasionally the seat of a peculiar variety of new growth, distinguished from all other as a *parotid glandular tumour*. Sometimes a similar growth is met with in connection with the submaxillary. It consists of fibrous, mucous, cartilaginous, and glandular tissue combined in varying proportions, and forms a firm elastic mass of an irregularly lobulated shape. Usually it is enveloped in a dense capsule and buried in the substance of the gland. Occasionally it is detached, lying on it, but in all probability developed in connection with it. It has been suggested that the presence of cartilage may be accounted for by the persistence of some portion of the branchial arches, the first in the case of the parotid, the second for the submaxillary.

Parotid tumours of this description are usually met with in young adults, and increase so slowly that little attention is paid to them. As age advances, however, they are liable to change their characters suddenly and develop into rapidly growing adeno-sarcomata; and sometimes they assume this character from the first, masses of vascular gland-tissue developing in some parts and soft sarcomatous growth in others.

When this occurs the tumour becomes painful and tender; the skin grows thin; the surface is reddened with dilated veins; and all the tissues near become involved. In a little while ulceration follows; the covering breaks down; gigantic fungating masses that bleed at the slighest touch protrude through the opening; hæmorrhage sets in; and partly from this, partly from septic absorption and exhaustion, the result not unfrequently proves fatal within a few months.

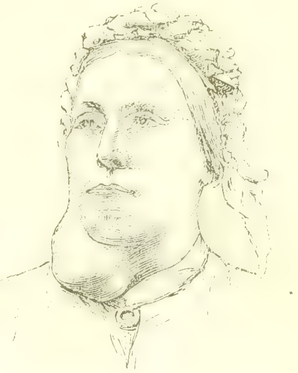

FIG. 328.—Submaxillary tumour.

Other tumours are seldom met with. Cysts may form either independently or in connection with other tumours, but they rarely attain any size. Mucous cysts are met with in the submaxillary, but probably not in the parotid. Lymphatic growths are occasionally found, and a few instances of fibromata and sarcomata are on record. It is questionable whether the cases of cancer were not really adeno-sarcomata, as the sarcomatous tissue is very unevenly distributed.

The only treatment is excision, but to be successful it must be done while the growth is small. The incision should lie over the posterior border of the gland; if necessary a second may run forwards from this at right angles to it. If the capsule is opened freely the tumour can sometimes be shelled out; but if it has deep connections, running, for example, down to the styloid process or behind the ramus of the jaw, or if the facial nerve, instead of lying beneath it, runs through it, the operation becomes exceedingly difficult. It is advisable if possible to keep inside the capsule; and if the facial nerve runs into the tumour an attempt must be made to dissect out the chief branches, but the result is rarely satisfactory. Facial paralysis invariably results if any traction is put upon the nerve in separating the tumour from it; but fortunately, unless the fibres are too much bruised, or are cut away to such an extent that the ends cannot be brought together, the muscles usually regain sufficient power to prevent conspicuous deformity. In cases of accidental division the ends should of course be sutured at once.

Excision of the parotid has been performed, but never with sufficient success to justify repetition.

CHAPTER XIII

DISEASES OF THE EAR AND LARYNX

By T. Mark Hovell

Section I.—Diseases of the Ear

Examination of the Ear

To ensure this being carried out thoroughly, it is well to adopt a definite order for employing the various tests to the patient's hearing and for inspecting the ear and other parts. This is best done by grouping the methods of examination which require light and those for which it is unnecessary.

Any *watch* may be used as a test for hearing, provided the distance has been ascertained at which its tick can be heard by a normal ear. This distance is recorded as a denominator, and the patient's hearing power is the numerator. Thus, using a watch which can be heard at six feet to test a patient who hears it at 36 inches with the right ear and 20 inches with the left, the result would be recorded: right $\frac{36}{72}$, left $\frac{20}{72}$.

A vibrating *tuning-fork* when placed on the vertex of the skull in the middle line should be heard equally in both ears, and when one meatus is closed with a finger the sound should be louder on that side, on account of the vibrations being confined and consequently to some extent thrown back upon the labyrinth. If therefore a patient hears a tuning-fork, applied as above mentioned, louder in the ear in which the hearing is impaired, it may be inferred that the conducting apparatus is at fault, and if it is not heard as well as in the other ear that the labyrinth or auditory nerve is affected.

Malingering may be detected sometimes by using the tuning-fork in this way, the impostor thinking that he ought not to hear so well with the ear closed.

The extent to which the labyrinth or auditory nerve is impaired may be roughly gauged by placing the tuning-fork over the mastoid process of the affected side and noting the number of seconds that the vibrations can be heard by the surgeon when the fork is applied to his own head after the patient has ceased to hear them.

The auscultation-tube is a piece of rubber tubing about thirty inches long, having at each end a hollow piece of ivory or vulcanite to fit the meatus. To distinguish the end used for patients, one ear-piece may be made of ivory, the other of vulcanite.

By placing one end in the patient's ear and the other in one's own the condition of the Eustachian tube can be ascertained whilst the tympanum is being inflated, by Valsalva's or Politzer's method or by means of a Eustachian catheter. Thus, if there is moist mucus in the tube or tympanum a bubbling sound is heard, or whistling if the calibre of the tube is narrowed. In cases in which the membrana tympani is perforated the injected air can be felt by the surgeon striking against his own membrane.

Valsalva's method of inflating the tympanum consists in expiring forcibly through the nose whilst the mouth is closed and the nostrils are compressed by a finger and thumb. In a healthy ear the entrance of air is accompanied by a feeling of fulness and slight cracking sound.

Politzer's method consists in holding a small quantity of water in the mouth, and then, whilst it is being swallowed, forcing air from an india-rubber bag through one nostril while the other is compressed with a finger or humb to prevent the air escaping. The sensation produced in the ear is similar to that caused by Valsalva's inflation, but more marked.

The late Dr. Peter Allen used to force air into both nostrils simultaneously by blocking their orifices with an india-rubber pad through which passed two pieces of tubing, one of which enters each nostril.

Instead of swallowing water, the naso-pharynx may be shut off by the patient whistling or uttering a guttural sound, such as 'huck.' In children it is unnecessary, as the Eustachian tube is more patent.

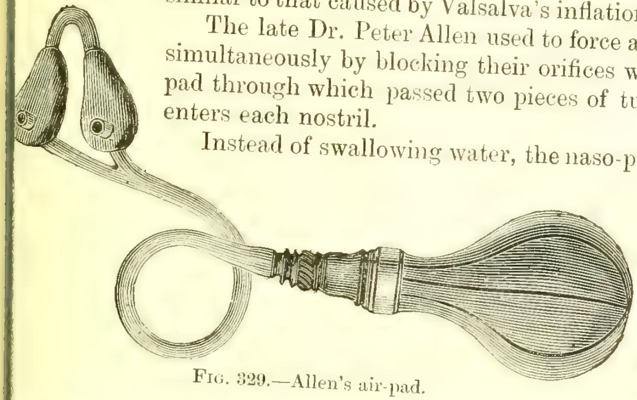

FIG. 329.—Allen's air-pad.

A Eustachian catheter should not be more than $4\frac{1}{2}$ inches long, and it is ost convenient to use one with a diameter of small size. Whilst introducing the surgeon should stand at the patient's right side with the catheter ld lightly between the thumb and index finger of his right hand, the beak curved end pointing downwards, and allow it to slip through the nostril il it touches the posterior wall of the naso-pharynx. It should then be ıdrawn half an inch and the beak turned outwards and sometimes slightly ards, when it will be found to be in the orifice of the Eustachian tube.

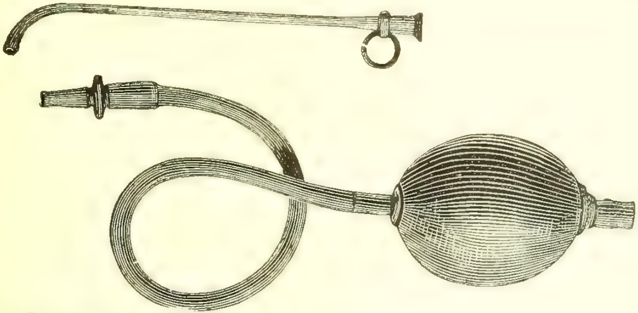

FIG. 330.—Air-bag with nozzle to fit a catheter, suitable also for Politzer's inflation with a teat slipped over it.

As the dimensions of the nostrils vary very much owing to deviations of septum, cartilaginous and bony spurs, and other abnormal conditions, e is no fixed rule for the position of the catheter during its passage. It ı passes best if the beak is directed horizontally outwards beneath the ior turbinated bone as soon as it is well within the nostril, turning it ı again a little as it goes through the choana. A catheter should always be passed with the greatest gentleness, and, in many instances, it is best to allow it to find its own way. Should it be impossible to reach the tube through one nostril, the curve of the instrument must be increased, and an attempt made to do so through the other. If the catheter is drawn backwards by muscular contraction, when the beak is turned outwards in the nasopharynx, it is an indication that it is behind the posterior lip of the Eustachian orifice. A special catheter with a distinguishing mark should be kept for syphilitic cases. If a nostril is extremely sensitive, it may be sponged with a four per cent. solution of cocaine.

As soon as the catheter is in position, the little and ring fingers of the left hand should be placed one on each side of the patient's nose, the palm of the hand being downwards and forwards, and the outer end of the instrument grasped between the thumb and index finger. By this means the catheter is firmly held, and the hand at the same time well supported against the patient's face. The nozzle of the air-bag should now be introduced, and the thumb and index finger of the left hand slipped forward to hold it in place. Air is then forced into the tympanum by compressing the air-bag. Many aurists prefer a modification of Politzer's bag, having a piece of tubing between the air reservoir and the nozzle, which prevents the movement of the bag being communicated to the catheter.

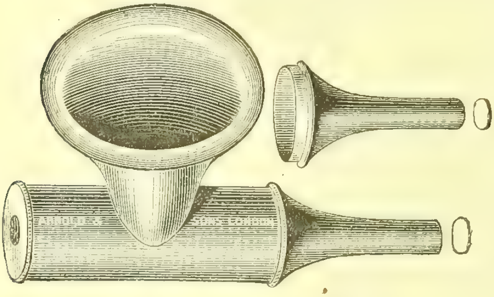

Fig. 331.—Brunton's auriscope.

For *examining the membrana tympani*, two kinds of speculum are used, one consisting simply of a funnel of metal or vulcanite, the other (Brunton's) of a metal funnel with a lens at the opposite end and an aperture at the side for the admission of light. For using the former daylight is sufficient, but for the latter artificial illumination is necessary. The focus for a Brunton's speculum should be three-quarters of an inch from the end when the centre of the cap containing the lens is level with the larger extremity of the speculum.

Before the speculum is introduced, any abnormal condition of the outer part of the ear should be noted, and the auricle raised upwards and backwards in order to straighten the canal.

A healthy membrane is of a bluish-grey colour, and is placed obliquely across the canal, its upper and posterior part being more external than the lower and anterior. Passing downwards and backwards and a little inwards, nearer the anterior than the posterior edge of the membrane, is a whitish ridge, the handle of the malleus, and passing forwards and downwards from its lower extremity, which is slightly enlarged, and situated just below the centre of the membrane, is a triangular glistening surface called th *cone of light*, having its base towards the periphery. At the upper part o the handle of the malleus is a white projection, the short process of th malleus, and stretching backwards and forwards from the short process t the edge of the membrane are two slight ridges, the anterior and posterio folds, the latter being the more clearly defined. Above these folds th membrana propria is absent, the part being called Schrapnell's membrane

Not infrequently a whitish line (showing the position of the long process of the incus) is seen behind, internal and parallel to the upper part of the handle of the malleus. Occasionally the outer part of the stapes can be distinguished.

After the position, colour, degree of transparency, and any abnormal condition of the membrane that may exist, have been carefully noted, the nares, pharynx, and naso-pharynx should be examined.

Diseases of the External Ear

Anomalous formations of the auricle are sometimes found; they are generally associated with defects in the meatus or the deeper parts of the ear.

Accumulation of wax is due either to increased activity of the glands, or to obstacles interfering with the escape of their secretion. The former condition is often associated with disorders of the external and middle ear, the latter may be produced by exostoses, or foreign bodies, or by the cerumen being pushed into the meatus during attempts to cleanse it.

The **symptoms** vary according to the size and position of the plug. They are, generally, deafness, often coming on or increasing suddenly, tinnitus, giddiness, and cough; usually there is no pain. The glistening surface of the wax has been mistaken for the membrana tympani.

Treatment.—Syringing with warm water is generally sufficient to clear the meatus if the stream is directed against its floor, but should the plug be hard and near the orifice it may be gently moved with a spud. If the syringing causes pain, the wax may be softened with the following drops:—

Sodæ bicarb.	gr. x
Glycerini	gr. iij
Aq. dist. ad	℥ j

If the ear is tender a few drops of liq. opii sedativus may be added. After the wax has been removed the meatus should be dried with absorbent cotton-wool and a piece kept in the meatus for some hours.

Othæmatoma, or blood-tumour of the auricle may occur spontaneously or be due to injury; the former is much more commonly found among nsane patients, and more often in men than in women. It appears as a swelling on the outer surface of the auricle, produced by the effusion of blood beneath the perichondrium. The size, outline, and tenseness of the tumour depend upon the amount; its colour, on the depth.

Treatment.—If the tumour is small and not very tense, it may be left to subside, or the fluid may be evacuated and pressure applied. Traumatic cases are sometimes attended by great disfigurement.

Fungi in the external auditory meatus are usually found where there has previously been disease of the parts, producing an accumulation of epidermic scales. There is usually tinnitus, pain, and impairment of hearing. On examining the meatus, the fungus is seen on the walls of the canal and often also on the tympanic membrane.

Treatment.—The ear should be syringed several times a day with a warm solution of perchloride of mercury (1 in 1000), or hyposulphite of soda (5 grains to ℥j). And then a few drops of warm alcohol should be put into the ear. This should be continued for several days.

Eczema of the ear may be acute or chronic; the former is more common, and is especially found in children and women. The origin of the affection is often obscure, but may at times be traced to local sources of irritation.

The **symptoms** of acute eczema have been already described. The meatus is not usually invaded, but when this occurs tinnitus and impairment of hearing are generally present. In chronic eczema the auricle is dry and scurfy, and fissures are very liable to form in the grooves and depressions; the meatus is generally involved. There is no strict line of demarcation between the acute and chronic forms; many are best described as subacute.

Treatment.—The general condition of the patient almost invariably requires attention. In acute stages anoint with vinolia or vaseline; if there is much inflammation lead lotion gives relief, or the part may be painted with a five per cent. solution of cocaine, and an ointment of ichthyol and vaseline (1 to 10) used. Crusts may be removed, after being softened with almond oil, and an ointment of zinc and boric acid, or salicylic acid and soap plaster (1 to 10), or balsam of Peru applied afterwards. For the scaly form white precipitate or boric acid ointment is a good application. Avoid syringing the ear. If necessary, cleanse it with absorbent cotton-wool.

Circumscribed or furuncular inflammation of the external meatus is usually found in the cartilaginous portion, and is often associated with deranged health; it may be due, however, to local irritation.

Symptoms.—If the deeper part is affected fever and even delirium may occur, especially in children. The pain often radiates over the side of the head, and is increased by movement of the jaw and by making pressure over the tragus; it generally increases towards night, and continues with but slight diminution until the abscess bursts or is opened. Deafness, when present, is mainly due to the obstruction. Tinnitus may be present. There is often no congestion of the meatus, but one or more extremely tender swellings inside. Recurrence is common, especially in weakly subjects.

Treatment.—Leeches may be applied to the tragus; plugs of gelatine containing $\frac{1}{6}$ grain of extract of opium inserted into the meatus; and an incision made into the swollen tissue. After the incision the parts should be painted with carbolised glycerine or solution of boric acid. Hot poultices should not be applied to the auricle. Opium should be given internally to relieve pain, and attention paid to the general health.

Diffuse inflammation is much more rare; it may be produced by irritation of the canal, or by the extension of inflammation from the middle ear. Various acute and chronic febrile disorders are sometimes attended by it.

Symptoms.—The subjective symptoms resemble those of the circumscribed form, but there is generally more deafness and tinnitus. The objective ones vary according to the stage and course of the disorder: the skin is swollen and often reddened, and the membrana tympani dull and hyperæmic. In some cases there is a copious formation of epithelial scales attended with slight fluid exudation. Perforation may occur.

Treatment is much the same as for the circumscribed form of inflammation. In the chronic stage finely powdered boric acid should be insufflated, and if this fails a few drops of a solution of boric acid in rectified spirit and water may be poured into the meatus. If the discharge is persistent the parts may be painted with a solution of nitrate of silver, 20 to 30 grains to ℥j.

Exostoses are generally multiple and sessile, and they vary in size from slight elevations to large rounded projections. They are often associated with chronic catarrh of the middle ear, and are also said to be caused by gout, syphilis, and sea-bathing. They grow slowly and should not be interfered with unless they close the meatus. They can be removed with a dental drill. Pedunculated growths are sometimes found in cases of chronic suppuration ; they grow quickly, and are, as a rule, easily removed with a pair of forceps.

Foreign bodies in the external auditory meatus.—When a patient is said to have a foreign body in the ear, the first step is to ascertain that the statement is correct. In the case of a child no detailed examination should be attempted until an anæsthetic has been administered. A foreign body may remain for weeks and even months in the meatus without doing much if any harm, while permanent injury may be caused by improper attempts at removal. If the meatus is swollen, and the foreign body is a substance not acted on by moisture, such as a button or bead, it is best to make no immediate attempt but to apply some soothing lotion, and wait until the inflammation has subsided. In many cases this course may be adopted, even if it is a pea or bean or other substance known to swell when moist. A foreign body can generally be removed by careful syringing, if the stream of water is directed between it and the wall of the meatus, and it is only in exceptional cases that forceps, hooks, &c., should be used. When permanent impairment of hearing follows, it is more often due to the attempts which have been made to remove it than to the effects of the foreign body itself.

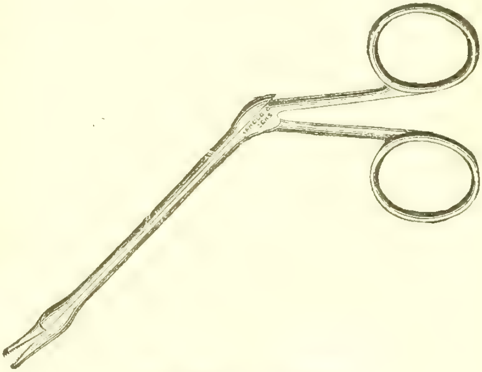

FIG. 332.—Ear-forceps.

DISEASES OF THE MIDDLE EAR

Acute inflammation of the middle ear is most frequently produced by a draught of cold air striking the ear or the extension of inflammation from the naso-pharynx, but it may follow the use of a nasal douche or sea-bathing.

Symptoms.—A feeling of fulness in the ear is first complained of, followed by pain of a throbbing or stabbing character, often radiating over the side of the head and increased by swallowing. There is deafness and sometimes tinnitus, with fever, especially in children. Tenderness over the mastoid process, and symptoms of naso-pharyngeal catarrh are often present. In the early stage the membrane looks a little dull and the vessels running along the posterior border of the handle of the malleus are congested. As the attack becomes more severe the congestion of the membrane increases and vesicles may form on its surface. The superficial epithelial layers become swollen and are thrown off in thick plates. If mucus or pus collects in the tympanum, the membrane becomes bulged outwards, and unless a puncture is then made in it rupture will take place, the escape of the fluid giving almost immediate relief to the symptoms. In some cases the symptoms subside without this stage being reached.

Treatment.—The patient should be confined to the house, and in an acute case to bed. An aperient should be given, and if much pain is present three to six leeches should be applied over the tragus and below the meatus, internal to the lobule. Hot fomentations and sedative drops may be applied to the meatus. The membrane should be punctured in the posterior inferior segment as soon as it begins to bulge. When the acute symptoms have passed off, air should be gently injected into the tympanum through a Eustachian catheter or by means of a Politzer's bag, at first once daily, the interval being lengthened until the hearing is restored. If there is any discharge from the meatus, finely powdered boric acid should be insufflated after the ear has been carefully dried with absorbent cotton-wool, or a solution of boric acid dropped in.

Chronic suppurative inflammation of the middle ear is the result of the acute form of the disease; it often continues for years if not efficiently treated, and may produce very serious complications. On examination, after the ear has been syringed, the membrane is dull and the handle of the malleus invisible, on account of the swollen condition of the epithelial layer; but if this is removed the colour is more or less red. If the perforation is large, the inner wall of the tympanum may be distinctly seen, and in some cases portions of the ossicula, the appearance depending upon the amount of congestion and the size of the perforation. The hearing is more or less impaired, and patients sometimes complain of giddiness, but tinnitus is not often present.

Treatment consists in keeping the parts scrupulously clean. The discharge should be washed away several times a day with a disinfecting lotion, and the meatus dried with absorbent cotton-wool wrapped round a probe, finely powdered boric acid being insufflated afterwards. As the discharge lessens, the application may be made at longer intervals. In old-standing cases the following drops, warmed, may be used several times a day:—Sulphate of zinc 2 to 8 grains, tinct. opii ʒ ij, water to ℥j. *Granulations* that spring from the meatus or membrane should be scraped away with a sharp spoon or destroyed with a saturated solution of chromic acid, according to their position, care being taken not to injure surrounding structures. *Polypi* attached to the tympanic cavity should be removed with a snare, unless very small. The wire should be passed as near as possible to their root and the loop then tightened until the polypus is grasped, when it may be dragged out; if the wire is tightened too much, the growth is cut and a portion of it left behind. The polypus may also be seized with forceps and twisted out. Before removal, a 10 per cent. or 15 per cent. solution of cocaine should be dropped into the meatus, and afterwards the root destroyed with a saturated solution of chromic acid, warmed alcohol being dropped into the meatus afterwards.

Inflammation of the mastoid cells may be produced by the extension of the disease from the tympanum. The symptoms are deep-seated pain and tenderness over the mastoid process, accompanied with more or less fever. When the periosteum is affected, the tissues behind the ear are swollen and the auricle stands out from the head. If pus has formed, fluctuation may be detected.

Treatment.—In the early stages, three to six leeches and hot fomentations should be applied over the seat of pain, and sedative drops to the meatus. If these measures fail to give relief, an incision should be made down the mastoid process and the periosteum divided. If the symptoms continue after this treatment, the mastoid cells must be opened. For this purpose a drill about an eighth of an inch in diameter is large enough; it should be provided with a guard to regulate its penetration. The opening should be made at the junction of a vertical line drawn a quarter of an inch behind the meatus with another line drawn horizontally on a level with its upper border. The direction is inwards, forwards, and a little upwards. Relief may follow the operation, although no pus is found in the mastoid antrum. The thickness of the outer table of the skull varies, but it is generally about a fifth of an inch in this position. If, on making an incision on to the mastoid process, pus is found to be escaping through an opening in the bone, it is best to enlarge it instead of making a fresh one. As soon as the mastoid cells have been reached, they should be washed out with a warm disinfecting lotion.

Caries and necrosis may attack the meatus, mastoid process, and tympanum. When this occurs the granulations constantly return, even after persistent attempts have been made to destroy them, and the discharge frequently remains offensive. Facial paralysis may be present. In children an anæsthetic should be administered, and if any caries is found the diseased surface should be scraped, and any sequestra that are present removed.

Phlebitis, when it occurs, generally affects the lateral sinus and jugular vein, and may produce pyæmia.

Meningitis and cerebral abscess may occur during acute or chronic suppurative inflammation of the middle ear, but are more often found in the course of the latter. If the position of the abscess can be localised, the skull may be at once trephined and the pus evacuated. An exploratory operation may be made in a severe case, although the precise seat of the abscess cannot be determined.

Catarrh of the middle ear is most frequently caused by the extension of the affection from the naso-pharynx. It may then be produced by the exanthemata, syphilis, even a 'cold in the head,' or any condition, such as adenoid growths, which keeps up a chronic state of congestion of the mucous membrane.

The **symptoms** complained of in the early stage are a feeling of fulness and pressure in the ear, and a cracking or bubbling noise when the nose is blown; the former is produced by the swollen condition of the mucous membrane lining the middle ear, the latter by the presence of mucus in the Eustachian tube and tympanum.

Except in very recent cases, the membrana tympani is driven in by atmospheric pressure, the counteracting air in the tympanum having become exhausted, and a fresh supply prevented by the swollen condition of the Eustachian tube. Usually the membrane looks more or less dull and thickened, and when it is much depressed the posterior fold stands out as a prominent ridge. If the membrane is stretched for a long time, it may atrophy in places and permanent contraction of the tensor tympani muscle result. Mucus may collect in the lower part of the tympanum, its presence being marked by the darker colour of the membrane with which it is in contact. When very thin the fluid changes its position with the movements of the head, and if a large quantity collects it bulges the membrane outwards.

If the progress of the disease is not arrested, permanent thickening of the tissues of the middle ear results, and the movements of the ossicula are liable to be impeded or entirely prevented. The symptom of the patient hearing better when in a railway carriage or vehicle in motion is often found in these cases, and calcareous deposits are frequently seen in the membrana tympani. Tinnitus is often present and usually increases with the progress of the disease.

There is another form of disease, called by different authors *dry catarrh, proliferous inflammation*, and *otitis media hypertrophica*, in which it is doubtful whether a catarrhal inflammation is connected with the gradual process of thickening which takes place. The arthritic diathesis and hereditary predisposition have been considered to be important factors in producing it. The base of the stapes and its union with the fenestra ovalis are frequently affected, although joints connecting the ossicles also are involved sometimes. The impairment of hearing is so gradual that the date of its commencement can rarely be ascertained with certainty. Later, tinnitus and even vertigo may occur. The membrana tympani is normal in position and appearance, and the Eustachian tubes are freely open to Valsalva's inflation, and generally more patent than in health.

Treatment should be directed to restoring the mucous membrane of the naso-pharynx and middle ear to a healthy condition and replacing the membrane in its normal position. In early stages inhalations of compound tincture of benzoin (one drachm to a pint of water at 140° F.) is beneficial. If the naso-pharyngeal catarrh has existed a few weeks, inhalations of chloride of ammonium, without or with the addition of a few drops of pine oil, may be used. When much tenacious mucus is in the pharynx, an alkaline lotion should be sniffed through the nostrils before each inhalation. When the catarrh is confined to the pharyngeal extremity of the Eustachian tube, a few drops of a weak astringent solution (such as sulphate of zinc, one grain to an ounce) may be injected through a catheter on to the affected part, or a solution of perchloride of iron (15 to 30 grains to an ounce) may be applied by means of a brush introduced through the mouth. In cases in which the tube is obstructed by tenacious mucus a few drops of a warm alkaline solution (bicarbonate of soda 3 grains to an ounce, or iodide of potassium 10 grains to an ounce) should be gently injected into it every other day through a catheter—later on, in some cases, it is well to use a weak astringent solution in the same manner. To restore the membrane to its proper position, Politzer's inflation should be used at first daily, and subsequently at longer intervals, according to the requirements of the case. Injection of air by this method is more efficacious than introducing it by means of a catheter. Adenoid growths in the naso-pharynx must be removed. Counter-irritation behind the ear is in some cases a useful adjunct to treatment.

Disease of the internal ear is usually associated with and consequent upon disease of the middle ear. Other causes are injury, such as a blow upon the head or the noise of repeated hammering, violent emotion, large doses of quinine or salicine, syphilis, and the acute specific fevers. Sometimes it arises from extension from within, as in meningitis and intracranial tumours. It may be diagnosed :—

1. By a tuning-fork held on the centre of the skull being heard less in the affected ear; or, if both are affected, being heard only slightly or not at all.

2. By the vibrations being audible to the surgeon when the fork is applied to his own skull after they have ceased to be heard by the patient.

3. By the vibrations being audible when the fork is held opposite the meatus after they have ceased to be heard with the fork applied to the bones of the head.

At present there is no method of determining whether the lesion of the auditory nerve is in the labyrinth or external to it, but the presence or absence of optic neuritis is an aid to diagnosis in some cases.

Menière's disease is caused by hæmorrhage into the labyrinth. The attack is ushered in with tinnitus and giddiness, generally sufficiently severe to cause the patient to fall. The giddiness is followed by faintness, cold sweats, nausea, and vomiting. After a time the giddiness subsides, but the hearing in the affected ear is usually lost.

Treatment.—In the early stages, rest, light diet, bromide of potassium. During the second or third week, Politzer recommends subcutaneous injections of pilocarpine (4 to 10 minims of a 2 per cent. solution daily). Quinine has been recommended, but, if given, its effects should be most carefully watched.

SYPHILITIC AFFECTIONS OF THE EAR

Condylomata and ulcers are sometimes found in the external auditory meatus. Acute catarrh of the middle ear, probably due to the periostitis, may occur, and when chronic catarrh is already present, it runs a much more rapid course than in ordinary cases, frequently leaving the patient extremely deaf, in consequence of the internal ear having become implicated. At puberty, subjects of inherited syphilis are liable to lose their hearing, in consequence, it is believed, of the disease affecting the terminal portion of the auditory nerve.

Special Symptoms

As the symptoms, tinnitus aurium and vertigo, are so frequently present in ear-disease, they will now be referred to specially.

Tinnitus aurium may be caused by: (1) irritation of the auditory nerve without the existence of sonorous vibrations, or (2) by the vibrations being present in the ear or conducted to it from adjacent structures. Abnormal pressure in the labyrinth is the most common cause of the first variety. It may be produced by the base of the stapes being forced inwards as a result of chronic catarrh, an accumulation of wax, swelling of the mucous membrane of the tympanum, or an accumulation of fluid in that cavity; by reflected irritation caused by cerumen or fungi in the meatus, carious teeth, or by inflammation in the gums, nose, or pharynx. In the other class an abnormal condition of the internal carotid or jugular vein, congestion of the ear, as a result of inflammation or a large dose of quinine or salicine, muscular contraction in the ear, or anæmia, is sufficient.

Treatment.—When due to chronic catarrh, subcutaneous injections of a 4 per cent. solution of nitrate of pilocarpine may be used in addition to the remedies already mentioned, three minims being injected once daily, and the patient kept in bed or in a warm room until the perspiration has ceased. This treatment should be persevered with for a month or six weeks. Counter-irritation over the mastoid process is chiefly of service in congestion of the internal ear; bromide of ammonium, with or without digitalis, where derangement of the general nervous system is present. Attention should be paid to the digestive organs, and iron given when anæmia exists. A weak current of electricity, 3 to 6 small Leclanché cells, sometimes gives relief, and alkalies, colchicum, and other remedies are required when the patient is very gouty or rheumatic.

Auditory vertigo is generally paroxysmal, but may be more or less constant. It is produced by irritation of the nerves supplying the semicircular canals, either by the pressure on the endolymph being increased or by a strong stimulus being reflected from near or remote parts.

Although it may be caused by disease of the internal ear, it is more often due to affections of the middle ear, causing pressure on the fenestræ or fixture of the stapes in an abnormal position.

Treatment.—Ascertain that there is no source of irritation in the external auditory meatus, and that no undue pressure on the fenestra ovalis is being produced by a deficiency of air in the tympanum. Leeches or counter-irritation behind the ear should be used if there is any congestion in the deeper parts. Bromide of potassium is useful in some cases, and may be given in full doses. Attention should be paid to the digestive organs.

SECTION II.—DISEASES OF THE LARYNX

EXAMINATION OF THE LARYNX

THE instruments used for examining the larynx are so well known that it is unnecessary to describe them. Before purchasing a frontal mirror, it is well to try whether a spectacle frame or an elastic band round the head is the more comfortable, because for constant use a strong preference is sometimes felt for one or the other. The aperture in the mirror should be elliptical in shape and not more than $\frac{5}{8}$ of an inch in the longest diameter; it should be made in the glass as well as in its metal back. A special set of faucial mirrors should be kept for syphilitic cases, and distinguished from those in general use by their handles being of a different colour. The mirrors which have been introduced with an electric lamp attached are mere toys and useless for continuous work.

To examine the larynx the faucial mirror should be warmed until the dimness which appears as soon as heat is applied has almost passed off. If held over the lamp until it has quite disappeared, the mirror is generally too hot. The tongue should then be protruded and firmly but gently held with a napkin between the thumb and forefinger of the left hand. Care should be taken to keep the under surface of the tongue from touching the incisor teeth: this will not occur if the forefinger is held horizontally and the left hand kept well raised.

While the tongue is held, the rays of light reflected from the frontal mirror must be focussed on the base of the uvula and the faucial mirror placed firmly but lightly against the same place, gently raising it so as to lift the soft palate. If the tip of the uvula is reflected in the mirror, this must be lowered a little. Patients should be directed not to hold their breath whilst their throat is being examined. When much irritability of the pharynx exists, a 4 per cent. to 10 per cent. solution of cocaine should be sprayed or painted over the soft palate and posterior wall. Occasionally the larynx may be examined without the tongue being protruded this method is sometimes useful when the pharynx is very irritable and a solution of cocaine is not at hand.

Inhalation.—Apparatus for the inhalation of medicated steam should be constructed so that the air may enter near the bottom of the vessel and bubble slowly through the whole depth of the fluid. Patients should be directed to breathe slowly, six or seven times a minute only, not to expire into the inhaler, and to remain indoors for twenty minutes or half an hour afterwards to avoid catching cold. Steam inhalation should be used at a temperature between 140° F. and 150° F.

Sedative inhalations may be composed of: tæ. benzoini co., ʒj; acid. benzoici, gr. iij, kaolin, gr. xii, and tæ. tolu, ♏ xviii; lupulin, gr. xxx; or sodæ bicarb., gr. xx, and succus conii, ʒij; a pint of water at 140° F. being used in each case: stimulating ones of two or three minims of oil of Scotch pine, oil of juniper or of creosote, with a few grains of light carbonate of magnesia, used in the same way.

Insufflation.—The patient should be directed to hold his tongue well forward with a handkerchief, using his right hand to enable the operator to direct the application by the aid of a mirror held in his left. If a powder is used the end of the insufflator is bent at a right angle to the stem, and the descending arm is not more than half an inch in length. Blowing down the tube with the mouth ensures a more accurate application than using a ball syringe. It is convenient to have the rubber tube which connects the mouth-piece with the instrument not less than fifteen inches long.

The best spray-producers are worked by compressed air, the high tension ensuring the even distribution and fine division of the fluid. There is not then the same tendency to cause coughing. Hand sprays should be fitted with two balls, the anterior being used as a reservoir. By compressing the tubing between this and the bottle until the moment the spray is used, the tension is increased and the fluid more finely atomised.

Brushes are necessary where a particular portion of the larynx has to be touched with the solution; they should be made so that they readily come to a point directly they are wetted. If too large, difficulty will be experienced in introducing them into the larynx. On the Continent and in America solutions are applied by means of a piece of cotton-wool twisted round a piece of bent wire, instead of a brush.

Inflammation of the Larynx

Acute laryngitis (*catarrhal laryngitis*) is most frequently met with in persons whose vital powers have become depressed by anxiety, excessive mental work or prolonged physical exertion, sedentary occupation or living in ill-ventilated rooms. The commonest exciting cause is sudden or prolonged exposure to a damp cold atmosphere or to a draught of cold air impinging upon the neck or an ear, especially when the skin is perspiring freely, but an attack may be caused by the inhalation of dust, fumes from chemical compounds, or a vitiated atmosphere heavily charged with tobacco-smoke. It is sometimes due to the straining of long-continued shouting, to paroxysms of coughing or speaking for a length of time in an improperly pitched tone of voice, or to the entrance of a foreign body into the larynx. In many cases the inflammation extends from the nares or pharynx, and occasionally from the trachea. Errors in diet, and particularly the free consumption of hot alcoholic drinks, may originate and keep up catarrhal laryngitis, especially in its subacute form.

The **symptoms** vary according to the stage and degree of the attack. At first there is diminution in the amount of secretion, and this gives rise to a sensation of tickling or dryness which frequently produces cough; later on the secretion of mucus increases, but it rarely becomes excessive. On making a laryngoscopic examination, the whole of the larynx is seen to be extremely congested, and in many cases an elliptical aperture between the cords is visible during phonation, produced by imperfect approximation. Erosions on the upper surface or inner border of one or both vocal cords are frequently met with, the places denuded of epithelium generally being oval in outline and lighter in colour than the surrounding tissues. True ulceration is never met with in laryngitis unconnected with constitutional disease. Occasionally after a violent fit of coughing blood is seen on the surface of the mucous membrane or extravasated into the submucous tissue. This condition has been termed laryngitis hæmorrhagica, but it hardly deserves a separate name, as it is only a chance occurrence. The voice may be merely hoarse or almost absent, its alteration in tone being dependent more upon the paretic condition of the vocal cords or mechanical interference with their movements, than the congestion or swollen condition of the mucous membrane of the larynx itself. Adults, as a rule, recover from an attack of acute laryngitis in a few days if treated from the commencement, but, if neglected, the affection may remain in the subacute form for some time and eventually pass into the chronic stage. In children acute laryngitis is a much more serious matter on account of the interference with respiration, due partly to the smaller size of the glottis.

Treatment.—The patient should be kept in a warm room on light diet, without any stimulants. Sedative inhalations should be given every three or four hours if the case is acute, or at longer intervals when less severe. A saline febrifuge should be administered, to which may be added a small quantity of opium to relieve the cough; the form which I prefer is a mixture of citrate of potash with the compound tincture of camphor. One or two drachms of the ammoniated tincture of quinine taken in water every three or four hours is sometimes useful. An aperient, especially a small dose of calomel, is often beneficial at the commencement. In children the air should be warmed and moistened by making a tent over the bed and allowing steam from a bronchitis kettle or Lee's steam draught inhaler to enter it.

Chronic Laryngitis

This often follows an acute or subacute attack, especially if it has been neglected; but any of the conditions that excite acute inflammation may induce it or maintain it when it has once commenced. A congested condition of the mucous membrane is very common in boys at puberty, owing to the hyperæmia that accompanies the sudden development of this organ (causing what is popularly known as 'cracked voice'); and a similar affection is present in most cases of old-standing disease and in chronic bronchitis. Men suffer more frequently than women, owing in all probability to more frequent exposure; children of both sexes are comparatively exempt.

The subjective symptoms in many cases are not marked, especially when there is no necessity to make frequent use of the voice. Slight irritation and dryness of the throat with a tickling cough are all that a patient usually experiences; but these speedily become greatly increased if the voice is used for any length of time, and a pricking or burning sensation in the throat may ensue, accompanied by a feeling of obstruction, which the patient endeavours to relieve by constantly 'clearing the throat.'

The objective symptoms are hoarseness, increased secretion, and certain definite changes in the tissues of the parts. A marked feature of this disease is that in recent cases the hoarseness is most noticeable when the patient begins to use the voice after having been silent for some time, the natural tone, however, being assumed in a few minutes. This phenomenon is probably due to the increase in the blood-supply and nerve-force to the part consequent upon the vocal effort. If the patient continues to use his voice a feeling of fatigue is soon experienced and hoarseness quickly supervenes. When the affection is less recent, the voice may be continually hoarse or even lost. Sometimes it is natural unless attempts are made to exert it, such as by preaching, singing, &c. In chronic laryngitis there is usually increased secretion of mucus, which may be seen adhering to the interior of the larynx and especially to the vocal cords, glueing the latter together. As a rule it is thick, greyish in colour, and at times, when expectorated, streaked with blood. If chronic bronchitis exists the secretion is more profuse and less tenacious in character. The larynx is generally more or less congested, but at times the hyperæmia is limited to a particular part of the cavity, a vocal cord or portion of one being not infrequently the only seat of marked increased vascularity. At times enlarged blood-vessels may be seen running parallel with the length of the cord along its centre or attached border, giving the part a streaky appearance. The mucous membrane is generally swollen, and in old-standing cases the submucous tissue also considerably involved. This thickening produces to some extent the hoarseness which accompanies the affection, but this symptom is at times greatly aggravated by the swollen interarytenoid fold interfering with the complete approximation of the vocal cords. As a result of chronic laryngitis, nodular excrescences are not infrequently met with, and the non-malignant forms of laryngeal growth owe their origin to long-standing hyperæmia.

Chronic inflammation of the larynx is often attended with changes in the tissues themselves, the subepithelial portion of the mucosa being converted into lymphoid tissue. In aggravated cases of chronic laryngitis one or both cords may be found persistently congested and the surface granular in appearance, or a portion of a cord (generally the anterior) may be seen to be markedly increased in size in consequence of the hypertrophied condition of the connective tissue of the part. Another feature noticeable at times in this affection is a paretic condition of some of the intrinsic laryngeal muscles, producing loss of power, even if not actual loss of movement, in one or both cords, usually however only in one. If but one cord is affected, on phonation the opposite one crosses the mesial line to approximate with it, provided the mucous membrane is not too swollen to allow of such movement. Erosions or shallow ulcerations, which extend no deeper than the epithelial layer, are not infrequently seen in this disease, a frequent seat being the posterior wall of the larynx and the cartilaginous portion of the vocal cords. In some cases of chronic laryngitis, especially those occurring in strumous persons, the sub-glottic region becomes especially involved, giving rise to hoarseness, which is often quickly followed by complete loss of voice. Thickening of the tissues, especially at the under surface of the vocal cords, is the condition which specially attracts attention when a laryngoscopic examination is made, the tumefaction often presenting the appearance of a second vocal cord immediately below the true one.

The surface of the swelling is generally smooth and whitish-grey in colour, but occasionally it is ulcerated and touched with red.

In some cases the disease appears to originate in the cartilage or perichondrium, the structures below the anterior commissure of the vocal cords, or those on the inner surface of the sides of the cricoid cartilage, being most frequently affected—both situations in which the mucous membrane is in direct contact with the perichondrium. In consequence of the swelling which exists in these cases, dyspnœa may occur to an extent which necessitates tracheotomy. In all cases of long-standing chronic laryngitis the individual and family history of the patient should be carefully enquired into and the lungs examined from time to time.

With efficient local treatment a favourable prognosis may be given, provided that (1) the disease is of comparatively recent date; (2) is not accompanied by any marked tissue-changes; (3) the exciting cause has been removed.

Treatment.—Unless remedies are persistently employed, the affection will remain stationary, even if it does not progress; or the symptoms may disappear for a time and then recur with the slightest irritation. Chronic laryngitis affecting the subglottic region is much more intractable than the ordinary variety, on account of the difficulty of applying remedies.

In cases of chronic laryngitis, which are not of long standing and which present no marked tissue-changes, stimulating steam inhalations—pine-oil or creosote, for example—are of very great service, but it is necessary to expire the vapour through the nostrils as well as draw it into the larynx, because the pharynx and nasopharynx are usually also involved. The inhalation of fumes of chloride of ammonium is useful in checking excessive secretion. It is essential that it should be neutral, as an excess of either hydrochloric acid or ammonia causes irritation.

In more advanced cases astringents may be applied to the larynx with a brush, or, better still, in the form of spray. A solution of chloride of zinc (15 to 30 grains to an ounce of water), or perchloride of iron (30 to 120 grains to an ounce of water), may be used with a brush. Should spasm of the glottis result from the application, the patient should be made to speak and repeat a word until the spasm subsides. Solutions for application in the form of a spray should be weaker:—

Chloride of zinc	2 to 10 gr. to ℥ j
Sulphate of zinc	2 to 10 gr. to ℥ j
Perchloride of iron	¼ to 2 gr. to ℥ j
Alum	1 to 10 gr. to ℥ j

Where there is much inspissated mucus adhering to the interior of the larynx, it is well to spray the cavity with a weak alkaline solution to soften the tenacious film and allow it to be got rid of before any other application is made. Should much thickening exist the stronger astringents must be used, and if these fail to reduce the hypertrophied tissue, it may be necessary to destroy it by means of a galvano-cautery. Where there is long-standing hyperæmia with diminished secretion, carbolic acid and glycerine (ʒss–ʒj of pure carbolic acid to ℥j of glycerine) may be applied. Turpentine is sometimes useful if the secretion is excessive. If paresis of the laryngeal muscles has supervened, electricity must be employed to the interior of the larynx, a constant or combined current being the most efficacious. As long as inflammation exists in the larynx it is obvious that the voice should be used as little as possible. When congestion or relaxation of the pharynx or nares is present it must be treated, and any local source of irritation removed. Attention should be paid to the general health, and tonics prescribed, or change of air recommended, as may be required.

Perichondritis of the larynx usually occurs as a sequel to some other disease, such as phthisis, cancer, syphilis, typhoid fever, or to an injury, but it may be primary. It is generally found in adults, and is more common amongst males than females. A dull aching pain in the larynx is often experienced, and there is generally more or less congestion, with swelling of the tissues over the affected part. Ulceration may occur, and if an abscess has formed and burst internally, pus may be visible.

Immobility of one or both vocal cords may result from the swollen condition of the tissues around the arytenoid cartilages, or from implication of the recurrent laryngeal nerve. Œdema is generally present in secondary perichondritis. The cricoid and arytenoid cartilages are most frequently affected, the inflammation usually beginning in the perichondrium. Beyond soothing inhalations and scarification (if there is much œdema) little can be done locally to arrest the disease. Leeches are occasionally useful in the early stages, and sometimes an abscess may be detected and opened with a laryngeal lancet before it has burst. Tracheotomy is often required. Dilatation with hollow bougies has been recommended to counteract the stenosis which often follows this affection, but the results of this method of treatment are unsatisfactory.

Laryngeal phthisis is usually associated with pulmonary disease, but it may be well marked in the larynx without any evidence of it in the chest, nd it is said to have proved fatal without any tubercle having been found n the lungs. The predisposing causes are the same as those of pulmonary hthisis. Males are more frequently affected than females, and most cases ccur between the ages of twenty and thirty. Excessive use of the voice ndoubtedly hastens the development of the disease.

Symptoms.—In the early stages there is nothing characteristic in the ppearance of the larynx beyond that of chronic laryngitis, but, as the disease dvances, the mucous membrane becomes thickened and infiltrated by the ubercular deposit, commencing over the arytenoid cartilages or in the inter-rytenoid fold, and spreading as a pyriform swelling towards the epiglottis. t may begin, however, in the epiglottis or other parts. By degrees the ther parts of the larynx become affected, until most if not all of the laryngeal issues are involved. It is unusual to find extensive infiltration confined to ne side. In the majority of cases pallor of the mucous membrane is a disinguishing feature of this disease, but as phthisical subjects are prone to atarrhal affections, congestion and erosions of the mucous membrane are ften present at the same time.

Tubercular ulcers have a marked tendency to coalesce, thereby givin the surface attacked a worm-eaten appearance. Individual ones are shallo and of small size, their floor having a granular appearance. Not infrequentl the epiglottis and the neighbouring structures are extensively destroyed Paresis of one or both vocal cords may be present, due either to tubercula infiltration of the laryngeal muscles or to the interference with their movements that arises from the swelling of the laryngeal tissues. The genera debility, however, the loss of tone in all the muscles, and the extreme bodil weakness induced by this disease are not without influence. The righ vocal cord is more frequently affected than the left, in consequence of th recurrent laryngeal nerve on that side being pressed upon by pleuriti exudation, or as a result of consolidation of the apex of the lung. Pressur from enlarged bronchial glands sometimes acts in the same way. Necrosi and caries of the cartilages may occur; wart-like excrescences are sometime seen projecting into the interior, and in cases not far advanced thickenin of the interarytenoid fold with irregular tooth-like projections may be see similar in appearance to those found in chronic laryngitis.

Hoarseness is often present in the early stages of the disease, but thi largely depends upon the condition of the larynx. At times the voice is almost lost in consequence of the imperfect action of the vocal cords, or th want of sufficient expiratory power in the lungs. Cough rarely fails, but i is not accompanied with much expectoration when the laryngeal changes are slight, unless the lungs are decidedly involved or catarrh is present.

In the earlier stages a certain degree of pain on swallowing may be experienced; later, as the swelling extends, there may be as well a feeling o obstruction to the passage of food. Still later, especially when the epiglottis and ventricular bands are involved, the greatest discomfort is produced by liquids passing into the larynx. Unless perichondritis is present there is no pain in the larynx except during deglutition. In giving a prognosis the most important points are the condition of the epiglottis and arytenoid cartilages and the extent to which ulceration has advanced.

Treatment.—In addition to the usual constitutional measures, local treatment is of service in modifying the progress of the disease and adding to the comfort of the patient. Lozenges containing a small quantity o opium or morphia are useful for relieving cough. During attacks of catarrh sedative inhalations give relief, and stimulating inhalations may be use when the tissues are anæmic and not much infiltrated. Lactic acid appear to arrest the spread of the affection; it may be applied with a brush, o injected directly into the tissues; a 20 per cent. solution being used at th commencement, and the strength increased to 40 or 60 per cent.

Astringents, applied either with a brush or by means of a spray, rarely d good, and frequently cause irritation. Considerable relief, however, may b obtained by the application of a 20 per cent. solution of menthol in olive oi It occasionally happens that the infiltration of the tissues of the laryn becomes so great as to require tracheotomy, but the operation ought nev to be done merely with the object of giving rest to the larynx.

The pain in swallowing may be somewhat relieved by the application cocaine and by thickening the liquid nourishment and directing the patie to swallow it in gulps. Patients have been recommended to lie in the pro position across a bed and to suck up the nourishment through a tube.

Lupus is usually associated with evidence of the disease on the skin the soft palate, but occasionally it is confined to the throat. It is more often found in females than in males, and amongst the lower classes of society. Its characteristic features are hypertrophic changes followed by slowly-spreading ulceration, the surface of which has a worm-eaten appearance; sometimes the hypertrophied tissues are nodulated. The mucous membrane is congested less than in syphilis, but more than in phthisis, and ts sensibility is usually diminished. The epiglottis is frequently attacked, and may be completely destroyed.

Syphilitic laryngitis is not an invariable accompaniment of the manifestations of the disease elsewhere, and often does not come on until some time after the pharyngeal symptoms have disappeared. Its most constant feature is congestion, which is usually difficult to remove. Mucous patches and condylomata are present at times, and have usually an oval or sometimes roundish outline; they are less persistent than in the pharynx and not always symmetrical, sometimes occurring on the ventricular bands and arytenoid cartilages or edges of the epiglottis. Erosions of the mucous membrane and superficial ulceration are not uncommon, and their tendency to recur is a marked feature of the affection. The degree of hoarseness is dependent upon the extent and position of the laryngeal changes, and although in most cases a natural tone of voice for conversation is eventually regained, the singing voice frequently remains impaired.

Tertiary syphilis of the larynx is usually marked by deep ulceration, but cases occur in which persistent congestion, accompanied by more or less thickening, with or without superficial ulceration, is the prominent feature. These changes sometimes make their appearance many years after the initial lesion, impairment of health generally being the determining cause.

The epiglottis is frequently the seat of ulceration, its lateral or upper border being usually first attacked. In the later stages of syphilitic disease œdema is often present. When false excrescences occur, they are generally situated on the interarytenoid fold or anterior surface of the posterior wall of the larynx. Gummata are occasionally found. The cicatrix produced by the ulceration may form a web between the vocal cords, and frequently causes stenosis, rendering tracheotomy necessary. The thickening around the cricoarytenoid joint not unfrequently leads to permanent stiffening of the articulation.

In many cases only general treatment is required. When there is much congestion, a sedative inhalation, such as benzoin, is beneficial, and, later, a stimulating inhalation, such as vap. pini sylvestris, will assist recovery. Long-standing congestion should be treated by astringents, applied either by means of a spray-producer or a brush. In cases of obstinate ulceration great benefit is sometimes obtained by heating calomel in the bulb of a glass tube and blowing it, whilst in a state of vapour, on to the affected part.

Leprosy.—The chief feature of laryngeal leprosy is extreme thickening of he mucous membrane; sometimes papillary growths or tuberous masses are present. The larynx is never affected unless the disease is present in other parts of the body.

Tumours of the Larynx

Carcinoma is more often found in males than in females. Epithelioma the most frequent variety, but encephaloid and scirrhus are said to occur. The subjective symptoms vary according to the stage of the disease and the part affected. Usually there is pain, confined at first to the larynx, but radiating to the ears and adjacent parts after ulceration has commenced. Dyspnœa and dysphagia follow sooner or later. Hoarseness is generally the most prominent objective symptom; it frequently precedes all others by a considerable period, but the voice is rarely entirely lost. When ulceration has commenced the breath may become excessively fœtid, and hæmorrhage may occur from a vessel being laid open. The glands are seldom affected, and then only when the disease is at an advanced stage. This is due to the lymphatics being less freely connected with the glandular system than those from most other organs, and for the same reason general cachexia and secondary growths in other parts of the body are rare. The disease first appears as a swelling, situated most frequently on one of the ventricular bands, although any other part of the larynx may be affected ; as it increases in size the outline becomes irregular, the colour becomes red from congestion of the mucous membrane (though sometimes it is a dirty grey), and ulceration quickly supervenes. Œdema is generally present in the later stage.

Treatment.—All growths of a doubtful nature should be removed by an intra-laryngeal operation for microscopical examination. If found to be cancerous, two courses are open: (1) to leave the disease to run its course; (2) to attempt to eradicate it by surgical interference.

With a view to the latter, thyrotomy, partial extirpation, and complete extirpation of the larynx have been performed, but at present the results of these operations are not encouraging. Many patients die from the immediate effects of the operation, and the disease is very liable to return, even after what appears to be complete removal. Thyrotomy cannot be recommended, in consequence of the difficulty of removing all the growth. The result of total extirpation of the larynx has been hitherto far from satisfactory. The percentage of mortality due to immediate effects of the operation is very high, and the pitiable condition of the patients who survive, even for a short time, detracts greatly from any advantage which may have been gained. The operation ought not to be performed unless the patient's sanction is obtained, after all the disadvantages as well as the advantages have been fully detailed to him. More may be said for a partial operation, especially if performed while the disease is still recent and apparently localised.

When the disease is allowed to run a natural course the average duration of life is eighteen months. If symptoms of stenosis arise, tracheotomy should be performed before the general health becomes lowered by insufficient aëration. Pain must be relieved by morphia, either injected hypodermically or insufflated into the larynx, and dysphagia met by the use of a feeding-tube or nutrient enemata.

Non-malignant growths most frequently occur in the larynx when congestion has lasted for some time, as in catarrhal or exanthematous laryngitis Males are more frequently affected than females.

Symptoms vary according to the nature, size, and situation of the growth. When it is attached to one of the vocal cords, the voice is generally altered in tone, and if it is of any size dyspnœa is usually present.

Papillomata are the most common. They are usually of a pink colour but may be white or bright red, and are generally sessile, and often multiple When removed they have a tendency to recur or to spring from a part of th larynx previously healthy.

Fibromata are of a brighter red, and round or oval in outline, thoug sometimes they grow out like cauliflower excrescences. They are always single and usually pedunculated; and the surface is generally smooth, though it may be rough, irregular, or wavy. There are two varieties, (*a*) the firm and (*b*) the soft. The former come next to papillomata in the order of frequency, and consist of bundles of white fibrous tissue covered with several layers of epithelium; the soft are comparatively rare, and consist of fibro-cellular tissue with serous fluid diffused through their substance.

Cystic tumours are not often met with; they are generally situated on the epiglottis or spring from the ventricle of Morgagni, and usually cause some local irritation.

Myxomata, or true mucous growths, *angeiomata*, or vascular growths, and *lipomata*, or fatty growths, are occasionally met with.

Treatment.—Most laryngeal growths can be removed through the mouth by means of forceps or a snare. If the patient is an adult, before the operation is attempted, the larynx and pharynx should be sponged with a 5 or 10 per cent. solution of cocaine; for a child 4 per cent. is sufficiently strong. When the parts are thoroughly anæsthetised, the patient should be directed to hold the tip of his tongue with a napkin in his right hand. The forceps and faucial mirror having been warmed, the mirror, held in the left hand, should be placed in position, and, as soon as a view of the growth is obtained, the forceps introduced, the blades being kept closed until the growth is reached. Unless the operator is skilled in intra-laryngeal manipulation, he ought not to attempt to cut or drag anything away unless he has seen that only the growth is between the blades.

Growths which are too tough to be extracted with forceps should be snared and slowly divided with the wire. Cysts may be crushed with forceps or laid open with a guarded lancet attached to a curved handle. After removal a solution of perchloride of iron, 60 to 120 grains to the ounce, should be applied every two or three days for a week or so to prevent recurrence.

It may be necessary to anæsthetise a child before attempting to remove the growth. When this is done the child should be seated in an upright position on a nurse's lap, the mouth kept open with a gag, and the tongue held out by an assistant. The collection of saliva often prevents a good view of the interior of the larynx being obtained.

In very exceptional cases it may be desirable to destroy the remains of a growth with the electric cautery. When this is the case, a suitable electrode having been selected, all the platinum with the exception of the point should be insulated by tying a thin piece of ivory on each side of it (vaccine points do very well), and coating them over with a thick layer of gum-arabic. The larynx must be thoroughly anæsthetised, and the electric current not allowed to pass until the point is resting on the surface which has to be destroyed.

An extra-laryngeal method of removing growths ought not to be resorted to unless the growth is causing danger to life, and an experienced intra-laryngeal operator is of opinion that no other procedure will be successful. This mode of removal is sometimes required when a growth is very large, has an extensive attachment, and is of very tough texture, or is situated where it cannot be reached through the mouth. It must, however, be remembered that the mere size, toughness, or extensive attachment, does not justify an extra-laryngeal operation being performed.

Disorders of Sensation

Sensory affections of the larynx are occasionally met with associated with some other disease.

Anæsthesia occurs as a sequel to diphtheria and in bulbar paralysis. When present in a marked degree there is danger of pneumonia being set up by particles of food passing into the air-passages.

Hyperæsthesia very often accompanies inflammatory conditions.

Paræsthesia is usually met with after a foreign body has lodged in the larynx, even when only for a short time, the sensation of its presence continuing for hours and even days after its removal. Sometimes this is associated with ill-health.

Neuralgia rarely occurs, and when present is merely a local manifestation of a general condition.

Electricity is of use in some cases of anæsthesia and in paræsthesia, if it persists; but when the latter has been caused by a foreign body, sedative inhalations or a few applications of an astringent to the affected parts are usually sufficient to effect a cure.

Muscular Paralysis

This may be due either (*a*) to disease or injury of the medulla oblongata or the nerves supplying the muscles, or (*b*) to affections of the muscles themselves. Among the diseases which produce these results may be mentioned syphilis, cancer, lead-poisoning, rheumatism, and exposure to cold.

Pressure on a recurrent laryngeal nerve affects the abductor before the adductor filaments. This injury is liable to be produced by goître, aneurysm, enlarged lymphatic glands, or thickening of the pleura at the apex of the right lung. When both groups of muscles are paralysed, the vocal cord on the corresponding side remains fixed in the cadaveric position, *i.e.* midway between extreme abduction and adduction, and on phonation the healthy cord is drawn to, or even over, the middle line, compensating for the immobility of the paralysed cord.

Paralysis of the abductor or adductor muscles may be unilateral or bilateral. When only *one abductor* is affected the voice is usually unaltered, but there is more or less dyspnœa and stridulous breathing. When *both abductors* are paralysed, the vocal cords lie almost parallel, but generally separated rather more behind than in front. The voice is usually but little altered; expiration is free; but inspiration difficult on the least exertion and attended with stridor, which is also generally present during sleep. It usually occurs in adults, and is more common in males than females, resulting from either neuropathic or myopathic changes.

When only *one adductor* is paralysed, the voice is hoarse or may be almost lost, and laughing, coughing, and sneezing are always altered in character.

Bilateral paralysis of the adductors (*functional aphonia*) is more frequently met with in women than men, and among young women than old ones. The subjects of this affection are often anæmic and in a feeble state of health, occasionally they are found to be suffering from some disorder of the sexual system. It may, however, result from catarrh, rheumatism, lead-poisoning, and other causes, and is often met with in the second and third stages of phthisis. Although the aphonia is usually constant, sometimes a few words are uttered in a natural tone of voice, especially those at the beginning of a sentence. A notable feature is that coughing and sneezing are little altered in character. On attempted phonation, although the vocal cords are adducted slightly, a considerable interval is left between them ; sometimes one is more affected than its fellow. The mucous membrane of the larynx is usually pale.

The central adductor (*arytenoideus proprius*) is often affected in conjunction with the lateral adductors, but may alone be paralysed. When in this condition there is loss of voice, and although the vocal cords approximate in the anterior three-fourths of their length they remain separated by a triangular opening in their posterior fourth.

The external tensors (*crico-thyroidei*) are occasionally paralysed in consequence of exposure to a draught of cold air on the neck, but violent or long-continued use of the voice, especially in the open air, may produce the same result.

The symptoms are : loss of voice, sometimes only gruffness, and when a finger is placed on one of the muscles during phonation no movement is detected. When the affection is bilateral the central portion of the vocal cords is depressed during inspiration and raised in expiration. The glottis also has the appearance of a wavy line.

The internal tensors (*thyro-arytenoidei interni*) are not infrequently affected as a result of over-fatigue of the voice, or strain from an excessive vocal effort. When this has occurred, the vocal cords appear slightly bowed outwards, leaving an elliptical aperture between them.

Treatment.—This must depend upon the cause and duration of the affection. If congestion is present, sedative steam inhalations, such as benzoin, should be employed, and when it has subsided the application of electricity to the muscles affected may be of service. This is done by attaching one pole of a battery to a metal disc fastened over the affected muscle by a piece of elastic tied round the patient's neck, and the other to a laryngeal electrode, contact being made by depressing the lever as soon as the end of the electrode touches the affected part of the larynx. In cases of bilateral paralysis of the abductors, unless the aperture between the cords is seen to enlarge within a short time after treatment has been commenced, tracheotomy ought to be performed without delay. In many cases of functional aphonia the application of a strong astringent (chloride of zinc 30 grs. to ℥j, or perchloride of iron 120 grs. to ℥j,) to the interior of the larynx is sufficient to restore the voice ; but, if this fails, faradism applied to the vocal cords will produce the desired result. Should the voice be lost soon after it has been regained, it is better to wait until the general health is improved, because the shock produced by the constant application of electricity, especially if a strong current is used, frequently tends to retard the ultimate recovery of the patient. In the treatment of laryngeal paralysis constitutional remedies are often required, and in some cases are more important than local measures.

Muscular Spasm

Spasm of the adductors of the vocal cords (*Millar's asthma*) is most frequently met with in children between six months and two years old, after which age the tendency decidedly diminishes. Males are much more subject to it than females, and those who are rickety are especially liable to be attacked.

Most cases are met with during the first few months of the year, in consequence of the more excitable condition of the child's nervous system at that time, dependent upon confinement to the house during the winter months.

Difficult dentition and intestinal irritation produced by indigestible food or worms are the chief exciting causes. Sometimes the attacks occur during sleep, but they may be brought on by the child crying, sucking, or being dandled.

Symptoms.—A severe attack begins with several short stridulous inspirations, followed by a longer and more noisy one, after which respiration ceases, the head is thrown backwards, and the spine bent in the same direction. The eyes are fixed or turn from side to side; the fingers are clenched over the thumbs and the wrists flexed; the feet are flexed and rotated slightly outwards and the great toes adducted. The child's face becomes dusky, and the superficial veins distended. Suddenly the spasm relaxes and the child recommences to breathe. Usually the attacks recur from time to time, sometimes at frequent intervals, but any one of them may prove fatal. Pyrexia is generally absent.

Treatment.—During the attack the child should be slapped on the back, cold water thrown on the face, and smelling-salts held to the nose. When the spasm has passed off an enema should be given and a mercurial purge administered. With a view to diminish the tendency of spasms, musk (gr. 1–3) or bromide of ammonium or potassium should be administered every three or four hours. The greatest attention must be paid to diet.

CHAPTER XIV

DISEASES AND INJURIES OF THE NECK AND THROAT

MALFORMATIONS

Branchial Fistula

The Eustachian tube is the modified first branchial cleft of fœtal life. The others usually leave no representative, but occasionally a fistulous opening is found at birth corresponding to one of them. The second and fourth appear to persist more frequently than the third; the former opens in the neighbourhood of the lesser cornu of the hyoid bone, and may or may not communicate with the pharynx: the latter lies just at the inner margin of the sterno-mastoid immediately above the sternum. Occasionally it opens into the trachea or pharynx. They give rise to no symptoms and usually require no treatment. Pedunculated fibro-cartilaginous masses are sometimes found in the neighbourhood of their external orifice.

Spina bifida, which occasionally oocurs in the cervical region, nævi, hydrocele of the neck, dermoid cysts and those developed in connection with the thyroid body and the thyroglottic canal, congenital lipomata and malformations of the pharynx, are described elsewhere.

INJURIES OF THE NECK

Wounds

Transverse incised wounds are frequently met with in the front of the neck. For the most part they are self-inflicted: many lie in the suprahyoid space; some in the thyrohyoid; and others again over the larynx or trachea. Generally, in right-handed people, they begin on the left, high up, and run obliquely towards the right, becoming less and less deep; and not unfrequently they are jagged, the skin rolling up into folds before the pressure of the knife, so that it appears as if several cuts had been inflicted. Sometimes they extend from one side to the other, dividing the trachea and œsophagus or both the carotid arteries, and even notching the vertebral column; much more often they are superficial, not penetrating perhaps into the deep fascia. There are various reasons for this: the edge of the knife in many instances is directed against the lower jaw; or the force is spent against the cartilages; when the head is thrown back the larynx is thrust forward and the vessels recede; resolution often fails at the last moment; and if the air-passages are opened the sudden collapse of the thorax, previously expanded to its utmost, is sufficient to interrupt the tension of the muscles and break the force of the arm. In this way the vessels escape unhurt in by far the larger number of cases.

Besides these, gunshot injuries and punctured wounds, stabs for example from behind, penetrating the apex of the lung, or involving the great vessels at the root of the neck, and even penetrating between the arches of the vertebræ into the spinal canal, are occasionally met with. Union by the first intention is the exception. It is almost impossible to keep the wound at rest, and partly owing to the elasticity of the skin, partly to the action of the platysma, the edges always curl inwards, so that perfect adaptation cannot be obtained. Death may occur almost instantaneously from loss of blood, arterial or venous; from air being drawn into a wounded vein; from suffocation owing to a detached portion of the tongue or one of the cartilages falling into the larynx or trachea; or from blood pouring into the lungs; or it may follow later from inflammation or other complications. Emphysema is not uncommon, but is rarely of much importance; spasm and œdema of the glottis may set in at any moment; food, dust, cold air, blood, or pus may find its way down to the lungs, and set up bronchitis or broncho-pneumonia; abscesses may form around the air-passages, and spread into the tissues of the neck, and down behind the cervical fascia to the pleura and pericardium; and if these complications do not prove fatal, perichondritis and necrosis of the cartilages may set in; granulations may spring up and close the larynx or trachea; a fistulous orifice may be left, or aphonia, dyspnœa, or dysphagia may persist for the rest of life, caused by the cicatrisation that takes place in the interior.

When the wound lies above the hyoid the facial and lingual arteries may be cut, the cavity of the mouth opened, and the tongue and epiglottis hacked in such a way that they fall back over the larynx and cause instant death. The hæmorrhage is usually free and the blood may pour down into the trachea as well as escape externally. Food and saliva pass out through the opening; the movements of the tongue are impaired (sometimes the hypoglossal nerve is divided); the elevators of the hyoid are cut across; and swallowing and vocalisation cannot be properly carried out. If the thyrohyoid membrane is divided, the epiglottis and even the arytenoid cartilages may be detached and hang down; or the aryepiglottic folds may be cut, and the superior thyroid artery and superior laryngeal nerve divided.

When the brunt of the force falls upon the cartilages the great vessels usually escape; they lie far back in the angle, and unless the incision begins under the ear, or traverses the cricothyroid space, they are generally well out of the way. The immediate risk, therefore, is not so great; but whenever the larynx is wounded, the danger of inflammation, of spasm and œdema of the glottis, and of food passing down into the air-passages, owing to the imperfect way in which they are protected, is very serious. Dyspnœa and a sense of impending suffocation are always present; the least attempt at swallowing or speaking brings on fits of spasmodic coughing; and, if the patient survives, permanent impairment of the voice is not uncommon.

Hæmorrhage is more frequent in wounds of the lower part of the neck; it may come from the carotid or thyroid arteries; from the anterior, external, or internal jugular veins, or even from the thyroid gland, which sometimes, when cut into, bleeds profusely; and, if the trachea is cut across, the blood may pour down into the lungs so as to cause instant death. Wounds of the trachea of themselves are not very serious; but when it is divided the two ends retract so that a wide space appears between them, the lower sinking down into the thorax and moving to such an extent with each inspiration that it is almost impossible to fix it. The œsophagus and the recurrent laryngeal nerve are often wounded at the same time. Punctured wounds at the root of the neck, if they involve the upper aperture of the thorax, are often fatal at once from injury to the great vessels; but instances are recorded in which recovery has taken place, even when the apex of the lung has been injured and the brachial plexus divided.

Treatment—Hæmorrhage must be stopped at once by pressure. If the vessel is a large one, the finger must be inserted into the wound and kept upon the bleeding point; division of one of the carotids is generally fatal immediately, but instances are on record in which the hæmorrhage has been stayed temporarily in this way, until better means could be adopted. If the wound is too large, or there are many bleeding points, a handkerchief, or a sponge, may be used; but care must be taken not to compress the trachea or to drive the blood down into it. Then, as soon as possible, the arteries should be secured, either by torsion or ligature at both ends, and the veins tied. Complete division of the internal jugular is not necessarily fatal; a small lateral wound should be treated as if a branch had been torn off from the side. In deep punctured wounds, behind the angle of the jaw, when the bleeding is plainly arterial, and when it is impossible to secure the vessel without a long and dangerous dissection, an attempt should be made to ascertain by pressure upon the external carotid whether it proceeds from one of its branches—and, if so, this should be tied; under other circumstances a ligature should be placed round the common trunk. Wounds farther back in the neck are still more serious. The vertebral artery, or some of the main branches of the occipital and superior intercostal, may be divided; or even the spinal cord may be injured. If an artery is severed an attempt must be made to tie it; if this fails the wound must be plugged from the bottom with some antiseptic. This has succeeded even in the case of the vertebral.

In other cases asphyxia is a more prominent symptom. When it arises from the entry of air into veins, or from blood pouring down the trachea, help, as a rule, is too late; but if a portion of the tongue or of the larynx has been detached, and is hanging over the aperture, it is sometimes possible to lift it out of the way in time. The subsequent treatment depends upon the extent of the injury. A deep ligature, for example, may be passed through the base of the tongue to keep it forward; the epiglottis, if extensively cut into, is better removed, and this does not seem to interfere with deglutition; otherwise it may be secured with sutures; and the same may be done with the other cartilages. Divided nerves, if the ends can be found, should always be drawn together again. Wounds of the œsophagus must be closed with catgut, but, especially if they are transverse, there is little chance of primary union. When the trachea is cut across an attempt must always be made to approximate the ends with sutures; but, owing to the extent of the retraction and the movement of the parts, this is by no means easy. Finally, if blood has poured into the trachea, as much as possible must be removed by means of suction or by feathers, so as to limit the area of decomposition and inflammation; with an extensive wound in the air-passages the patient cannot cough it up.

If the incision is of great length, sutures may be inserted at the ends to draw the edges together, but even then they rarely unite by the first intention: the central portion, if the air-passages have been wounded and cannot be secured by sutures, should be left open, so as to afford free exit for the discharge, which might otherwise find its way into the lungs. Gaping is prevented, as soon as the patient is placed in bed, by raising the shoulders and fixing the head with bandages in a position of moderate flexion, taking care of course not to force it down so far as to interfere with respiration. If the larynx is badly injured it is better to perform tracheotomy at once and insert a rubber tube ; it is almost sure to be required later on for œdema or spasm of the glottis, to prevent the entry of foul air or discharges into the lungs, or from narrowing of the glottis owing to the cicatrisation and growth of granulations.

A thin flat sponge wrung out of hot water should be laid over the wound to prevent dust entering in ; and the air of the room must be kept warm and moist by means of a steam-kettle. Bronchitis is nearly sure to occur if the air-passages are opened, and is very likely to run on to pneumonia. The patient is often broken-down in health already, and is in a state of extreme depression ; he is weakened still further by hæmorrhage ; coughing is impossible owing to the position of the wound ; and even if blood does not enter the lungs, and decompose there, inflammation is very likely to extend down from the seat of injury, or be caused by particles of food, or by the air that has been fouled in passing over a septic surface. The diet must be nutritious, with a moderate amount of stimulants ; and the patient must be fed either with enemata or by means of a tube passed down into the stomach. The danger is greatest if the œsophagus or pharynx is opened ; but if the muscles of the floor of the mouth are divided, or if there is any extensive injury to the upper part of the glottis, the same precautions must be taken. The larynx loses its power of protecting itself ; coughing is impossible owing to the escape of air ; and often the sensibility of the mucous membrane is impaired. A soft india-rubber tube is generally sufficient ; it may be passed either through the mouth or nose (never through the wound), and care must be taken to make certain that it has not accidentally entered the larynx. Liquid food may be poured down this by means of a funnel every four hours without much inconvenience to the patient and without any risk. In all suicidal cases the patient must be carefully watched, for fear of doing himself further injury ; sometimes it is necessary to restrain the hands, but when possible this should be avoided. Little can be done for the despondency that is so often present ; if there is sleeplessness or much excitement chloral may be given : bromide is too depressing and opium is inadvisable in bronchitis. The prognosis in such cases is much worse than might be expected from the extent of the wound.

If dyspnœa arises the wound must be examined at once, and if necessary, tracheotomy performed. Occasionally this is required at a later period, owing to irregular contraction or cicatrisation in the interior, or to the presence of exuberant granulations, which cannot be got rid of by scraping or cauterisation. Quinine, carbonate of ammonia, ether and other stimulants must be given freely if pneumonia sets in ; and the side of the chest may be enveloped in a poultice ; but the signs are often too obscure until it is well advanced. There is no rise of temperature in many cases, and expectoration is absent ; the face is pale and dusky, the forehead covered with beads of perspiration, the respiration short and jerky and the pulse small and quick. Generally the patient rapidly falls into a kind of stupor. Deep-seated abscesses and cellulitis of the neck are usually accompanied by rigors and high fever: and the local signs are well-marked. Sometimes the inflammation extends along the outside of the trachea into the mediastinum, and causes pleurisy and even pericarditis. If a fistulous opening is left it may be cured by a plastic operation, paring the edges and bringing them together with numerous points of suture; or even by gliding a piece of skin over it from one side or the other, provided that it is certain that the patient can breathe sufficiently well when it is covered up.

Fracture of the Hyoid Bone

Owing to its protected situation this is rarely broken except by direct violence, such as a blow or a squeeze, as in hanging. The greater cornu is the part that usually gives way. One or two instances, however, are recorded in which it was produced by muscular action alone.

The **diagnosis** is seldom difficult: unless there is much swelling or ecchymosis, the fragments can generally be felt from the outside, and always by introducing the finger into the mouth. There is intense pain on pressure, or on attempting to speak or swallow. Very often the fracture is compound, one of the ends having perforated the mucous membrane, and there is a profuse secretion of saliva mixed with blood. Sometimes the swelling extends to the larynx, so that the dyspnœa becomes serious.

Treatment.—The fragments must be brought into position by manipulation, and the head and neck fixed, as far as possible, by a splint moulded over the shoulders and up the back of the head. Swallowing is so intensely painful, and sometimes sets up such an amount of coughing and irritation, that the patient may have to be fed by enemata for a few days, until the fragments are consolidated, or an œsophageal tube can be used. If the dyspnœa is severe, particularly if the fracture is compound, and if, as often happens, the wound becomes septic from the entry of food and other substances from the mouth, so that there is risk of acute laryngitis setting in, tracheotomy may be required at a moment's notice. Union generally takes place in three or four weeks, but suppuration, necrosis, œdema of the larynx, and septic pneumonia are not uncommon.

Dislocation of the hyoid bone, or displacement consequent upon relaxation of the ligaments connecting it to the thyroid cartilage, has also been described.

Fracture of the Cartilages of the Larynx

This may be caused in the same way; even the trachea has been torn across by a violent blow from the point of an elbow. The thyroid, owing to its size, position, and rigidity, is the one that usually suffers: sometimes the cricoid is broken as well.

This accident may prove instantaneously fatal from obstruction or spasm of the glottis. Even when there is not much deformity the swelling, ecchymosis, and emphysema seriously narrow the rima glottidis and cause very alarming dyspnœa. In general there is the most intense distress, with a sensation of impending suffocation, or this may be absent at the first and then come on suddenly. The treatment is the same as for fracture of the hyoid, but unless the portion of cartilage broken off is very small and altogether external, so as not to involve the mucous membrane, tracheotomy or laryngotomy may be required at a moment's notice. The latter is preferable, as the opening can be used to restore the displaced cartilage to its position or to fix it by sutures.

Contusion is much more common, and when severe—as, for example, in garotting—so that there is hæmorrhage under the mucous membrane, may give rise to the same symptoms. It is said that sudden death has been caused by this or by spasm, without any fracture. Care must be taken not to mistake the crackling sensation that is often felt when the larynx is moved from side to side upon the vertebral column for cartilage-crepitus.

FOREIGN BODIES IN THE AIR-PASSAGES

Irritating vapours rarely penetrate beyond the larynx: usually they are driven out at once by coughing, and cause merely a transient hyperæmia, though this may run on to inflammation. The same with liquids, unless the larynx has lost its sensitiveness or the muscles are paralysed. After diphtheria, for example, or when a patient is under an anæsthetic, or after wounds involving the floor of the mouth or the upper part of the larynx, when the mucous membrane is dry and insensitive, it is not uncommon for blood or liquid food or material vomited up from the stomach to find its way down through the larynx into the trachea and lungs, and, decomposing there, set up broncho-pneumonia. Solid substances cause symptoms of much greater intensity.

As a rule they enter by the mouth; occasionally they ulcerate through from the œsophagus, especially in malignant disease. In the vast majority of cases this accident is the result of the careless habit of holding things in the mouth or between the teeth, especially with children. Something or other—a laugh, or a blow upon the back—causes a sudden inspiration, and the foreign body is sucked down into the widely-open glottis and lodged in the air-passages before it is known that the hold on it is lost. Blow-tubes and pea-shooters are responsible for many, the child in filling its chest with air drawing the projectile right into the larynx. In operations about the mouth, when the patient is under an anæsthetic, it has happened many times: sets of false teeth, or wedges used to hold the mouth open, or teeth dropped from the forceps after extraction, in the haste to grasp another, are all recorded as having fallen into the larynx. The same thing may occur in the vomiting that follows anæsthesia. A case of sudden death after the administration of ether was found to be due to the skin of a ripe plum rolled up: it had been vomited, drawn into the larynx, and was firmly wedged in the right bronchus, so that its end fell over and covered the orifice of the left. Round worms from the digestive tract, vomited during sleep, have been known to lead to the same result.

Symptoms.—These vary according to the position, whether it is in the larynx itself, in the trachea, or in the smaller bronchi. They may be immediate, due to obstruction or irritation, or secondary, caused by the inflammation that invariably follows sooner or later.

1. *In the larynx.*—If it is large and round, so as to fit upon the rima glottidis, or sharp and angular, so as to cause spasm, suffocation may be immediate. The symptoms are of the most urgent description: the patient starts up wildly, gasping for breath, and clutching at his collar; the face is livid, rapidly becoming cyanosed; the veins on the forehead and neck stand

out like cords; he may be quite unable to speak, or, if the larynx is not quite closed, utters the most distressing sounds, attempting at the same time to push his finger down his throat; expiration and coughing become more and more violent, until the body becomes convulsed, a cold sweat breaks out, and within a minute he falls down unconscious.

In most cases, however, the immediate effect is not so intense: if the foreign substance is smooth, so that it does not set up much irritation, or if it is lodged in some place out of the way, like one of the ventricles, the symptoms may be comparatively slight, although the patient is never free from danger. The cough is characteristic: it comes on in spasmodic fits of uncontrollable violence and often continues until the patient is utterly prostrate from exhaustion. The least change of posture is sufficient to induce it. At first it is dry without expectoration, but afterwards, when inflammation sets in, this may be copious, thick, and stained with blood. Sometimes, especially in children, the symptoms bear some resemblance to croup; but as a rule, when they are due to a foreign body, expiration is more difficult than inspiration. Pain, a sensation of tickling often referred to the ear, and a sense of anxiety or of impending suffocation, are nearly always present. The voice may be quite lost from the first, or, if not, it always becomes hoarse in a few hours, from the swelling and œdema that follow. Later on, if the foreign body is sharp and angular, so as to cause inflammation and ulceration of the mucous membrane, death may ensue from spasm and œdema of the glottis; necrosis of the cartilages may occur; the inflammation may spread to the lungs and cause pneumonia; even blood-vessels may be ruptured, or the patient may die at length, worn out and exhausted. A coin, on the other hand, has been known to lie, coated over with mucus, in one of the ventricles for many months without causing urgent symptoms.

2. *In the trachea.*—If the foreign body is fixed, like a puff-dart, which lies with its point uppermost and with each expiration is driven farther and farther into the substance of the trachea, the immediate symptoms are not so striking. There is dyspnœa, but the cough is more continuous and is not of the same spasmodic uncontrollable character. Aphonia is not present until the mucous membrane of the larynx becomes swollen from the constant effort at expulsion. Pain is always felt over the actual spot, and there is constant soreness behind the sternum. Inflammation, however, with ulceration and copious expectoration, very soon makes its appearance and extends rapidly to the lungs. If, on the other hand, the foreign body is free, the symptoms depend chiefly upon its shape and weight. At one moment it lies over the bronchi, generally the right, owing to the position of its orifice; the next, it is coughed up against the larynx, and starts a violent paroxysm. Sometimes the patient is so fortunate as to cough it out, with instant relief; sometimes, on the other hand, it becomes impacted in the rima glottidis, or is caught and held by the muscular spasm, and immediate death ensues. Often the patient is conscious that it shifts its position. Sometimes it can be heard and even felt from the outside.

3. *In the lungs.*—When a foreign body is lodged in one of the bronchi there is rarely the same urgency. Dyspnœa, cough, copious expectoration, pain, and anxiety are all present, but the distress is not so extreme, and there is not the same sense of impending suffocation. If it lies in one of the large bronchi, valuable evidence may be gained from an examination of the chest. If the obstruction is only partial, the movement on that side is

diminished, the respiratory murmur is fainter, and, generally, an unusual whistling sound is heard as the air rushes past the obstruction, unless this is drowned by the coarse *râles* caused by the large amount of secretion that is poured out. On the other hand, should the whole of one lung or of one lobe be shut off, vocal fremitus and the normal vesicular murmur are wanting, and, after a time, the percussion note becomes dull, while the respiration in the rest of the lung is puerile.

Inflammation, when a foreign body is in the lung, may be long delayed (especially if it is of an unirritating character), but it always breaks out at last. Suppuration sets in, abscesses form and lead to destruction of the lung; gangrene, hæmorrhage, or empyema may occur; tuberculosis may break out, and the end nearly always comes within a few weeks, though sometimes not for years. Only exceptionally has the foreign body found its way out at length through the wall of the thorax in the pus of an empyema.

Diagnosis.—In the absence of history this is often impossible; no single symptom is peculiar to this accident. Many cases have occurred in which the presence of a foreign body has never been suspected (especially in the lungs); and nearly as many in which the suspicion has been wrong. In children the difficulty is peculiarly great.

Asphyxia may be caused by a foreign body driven into the pharynx; but, as a rule, there is no time for exact diagnosis; if it is not dislodged at once by the patient's own efforts or by the introduction of the finger into the throat, instant laryngotomy affords the only hope.

Inflammatory affections, croup, especially in children, and laryngitis are more difficult. The most important feature is the rapidity of the onset, and the extreme urgency of the symptoms, without, at first, any rise of temperature or sign of fever. In spasmodic croup, inspiration is more difficult than expiration. Hysteria, reflex irritation arising from disorders of the digestive tract, especially in children, spasm and œdema of the glottis, even aneurysm of the aorta, and whooping-cough, occasionally give rise to difficulty, especially if there is a history of a foreign body having disappeared from the mouth at the time of the onset. It is more common for a foreign body to be overlooked.

If the symptoms are very acute, particularly if there is violent suffocative cough recurring in spasms, it is probable the foreign body is in the larynx, or else that it is loose in the trachea, and is coughed up against it. When they are severe at the first, and subside without expulsion, it has probably either become lodged in one of the ventricles or has passed down into the bronchi.

Treatment.—In some cases the symptoms are so urgent that laryngotomy (as being the most speedy) must be done at once with anything that is at hand. Even when the pulse can no longer be felt at the wrist, this may succeed with the help of artificial respiration. When not so urgent, and when, as usually happens, the patient is seen for the first time after the immediate paroxysm has subsided, the first thing is to ascertain the position.

If it is in the larynx it may be extracted by means of the laryngoscope and laryngeal forceps. A 5 per cent. solution of cocaine brushed once or twice over the mucous membrane renders it white and perfectly insensitive, so that thorough examination can easily be carried out without fear of spasm. Or the same effect may be produced, though not nearly so well, by the prolonged application of ice, by the inhalation of chloroform vapour, or by injecting a small quantity of morphia just over the superior laryngeal nerve, at the greater cornu of the hyoid bone. If this fails, the choice lies between subhyoid pharyngotomy, laryngotomy (or laryngo-tracheotomy, if more space is required) and vertical division of the thyroid cartilage, according to the nature and position of the foreign body. Then it must either be extracted through the wound or pushed up from below. In no case should a patient be left without assistance if there is a foreign body in the larynx or floating in the trachea, especially if there has been already a severe attack of spasmodic dyspnœa.

When it has passed beyond the larynx, and is fixed either in the trachea or in the lungs, there is not the same degree of urgency or such immediate risk to life. Tracheotomy, however, is usually advisable. It is true that it has been shown by statistics that in a very large proportion of cases expulsion takes place without; and, still further, that the percentage of deaths in those cases in which tracheotomy has been performed is higher than those in which it has not; but I think it will be granted that, given any individual case, the chance of safe expulsion is much greater after the trachea has been opened, and that the risk to life is not appreciably increased by the operation. No cannula should be inserted; retractors, easily made with a piece of bent wire, should be fixed in the tracheal opening and fastened round the neck with an elastic band, so as to keep up a certain degree of tension upon the orifice, or Golding-Bird's dilator may be used. Sometimes expulsion is immediate, or the foreign body is coughed up so that it projects in the tracheal wound, or it is dislodged by inversion combined with compression of the thorax, especially if it is round in shape and of some weight; emetics and sternutatories have been successful, but no reliance can be placed upon them; or it may not happen for some days. There are many instances in which a cannula has been inserted and worn for some time, and then, quite unexpectedly, perhaps from changes it undergoes itself, or from ulceration around it, the foreign body has suddenly become detached and been expelled.

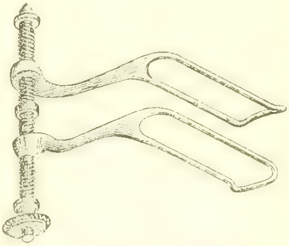
FIG. 333.—Golding-Bird's dilator.

If this does not take place within the first four or five days, the air-passages must be explored with probes, hooked at the end, tracheal forceps (either Gross's, which are made of German silver, so that they can be bent to any shape, or Mackenzie's, or Durham's, which are so contrived as to open only at the extremities), and even with the finger. All these attempts cause violent expiration, and sometimes in this way, sometimes by being actually hooked up, foreign bodies have been extracted even from the right bronchus. Care must be taken, however, not to mistake the rigid angle between the bronchi for one. Much depends upon a knowledge of the shape: tubular bodies may be laid hold of at the margin, or drawn up by passing both blades of a pair of forceps inside, and then separating them; the worst of all are puff-darts, which become firmly wedged in.

Afterwards the same precautions must be taken as after tracheotomy: the patient must be confined to his room, the air kept warm and moist, the wound covered with moistened gauze, and, so long as there is any fear of spasm or œdema of the larynx, the cannula should be retained and the patient fed by an œsophageal tube. A certain amount of thickening and irritation of the mucous membrane, with profuse expectoration, and, possibly, the growth of granulations, is very likely to persist for some time.

In older cases, when some length of time has elapsed since the entry of the foreign body, the question of surgical interference must be guided mainly by the condition of the lungs.

Scald of the Glottis

In gas-explosions and fires the pharynx is occasionally burnt, from the heated air or flame being drawn into the mouth; scalding is more common, especially in young children, from trying to drink out of the spout of a kettle. In either case the chief danger arises from the injury to the upper part of the larynx, which may be badly hurt from the flame or steam being sucked down into it by the inspiration which precedes a scream. The œsophagus usually escapes, unless there is a determined attempt to drink the fluid, and it is thrown at once to the back of the mouth.

Unless the accident is seen, or there is other external evidence, the diagnosis must usually be made from the sudden onset of extreme dyspnœa. The lips and mouth may be blistered, but they often escape, as the fluid passes right to the back and is ejected through the nose. There is constant screaming, until, partly from exhaustion, partly from swelling and œdema, the voice is completely lost, and nothing can be heard but a hoarse, croupy inspiration. Dyspnœa may be present from the first; often it sets in with much greater severity after a few hours, especially towards evening; the pain is very severe; swallowing is almost impossible; and even in children there is the most terrible apprehension. If the finger is introduced into the mouth the epiglottis can be felt hard and shrivelled, and, passing back from each side of it, two smooth rounded bodies, which project upwards on either side of the aperture of the larynx and almost close it. These are the aryepiglottic folds, which become œdematous and swell up to such an extent that when the tongue is depressed they may be seen as shining, rounded, semi-translucent masses, reaching nearly to the middle line. In severe cases the mucous membrane at the base of the epiglottis, the false vocal cords, and even the larynx below the rima glottidis, are more or less in the same condition.

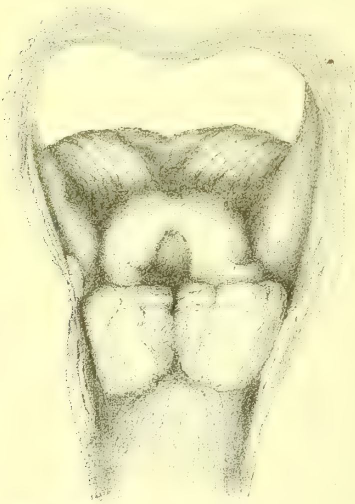
Fig. 334.—Œdema of the glottis, seen from behind.

Death may occur from asphyxia within a few minutes of the accident; more often the dyspnœa becomes worse and worse; the voice is completely lost; inspiration is hoarse and croupy, the lower ribs sinking inwards at each attempt; and the child sits propped up, perfectly quiet, with its chest thrown forwards and its chin upwards, so as to secure the greatest muscular aid. The face is pale and cyanosed, the lips dusky, the forehead covered with beads of perspiration—in short, there are all the signs of imminent suffocation. Later, if spasm of the glottis does not set in and prove immediately fatal, death may occur from exhaustion, from broncho-pneumonia due to extension of the inflammation, or from collapse of the lungs. Even in the slightest case the prognosis is very unfavourable.

Treatment.—The first object is to prevent the inflammation spreading, and to protect the mucous membrane. When this is inflamed, and the cavity of the glottis already narrowed, the slightest irritant, one that under ordinary conditions would merely cause a transient cough, may bring on an attack of fatal spasm. The air must be kept warm and moist, without, however, placing the child in a steam bath; ice must be placed round the neck by means of a collar; leeches may be applied outside; and the child must be kept perfectly quiet, sitting up. In adults, the hyperæmia and sensitiveness of the mucous membrane may be kept in check by constantly sucking ice. Small doses of calomel (gr. j to gr. ij) every hour until there are free bilious evacuations, or very small ones of antimony or aconite, may be given in vigorous children if the fever is setting in with severity; and if there is much secretion, an emetic—alum for example, which does not cause depression afterwards. If, however, the dyspnœa continues to increase, particularly if there are recurrent attacks of spasm, and if the chest-wall is beginning to fall in, there is no choice but free scarification of the aryepiglottic folds, intubation, or tracheotomy. The first of these is easily carried out with an ordinary bistoury, the edge of which is guarded up to within a third of an inch of the point with a spiral piece of strapping; the forefinger of the left hand acts as a guide, and free incisions may be made without danger. I have known this followed by considerable relief, but as a rule it is only temporary.

Intubation is more difficult to carry out, and requires special appliances, such as MacEwen's or O'Dwyer's tubes; but this or tracheotomy must be resorted to, unless scarification affords distinct and lasting relief. It is true that, especially in children, opening the trachea is a serious operation, and adds an additional cause for the broncho-pneumonia which so commonly sets in; but it enables the child to breathe freely, for a time at least; it prevents exhaustion and the continued battling for air; it stops the collapse of the lung and the danger of hepatisation; and it is the only effectual protection against spasm. If it is reserved to the last, and only performed in cases that are already desperate, the ill-success that attends it should not be laid entirely to the credit of the operation.

INFLAMMATORY AFFECTIONS

Owing to their exposed position, all the tissues of the neck are very liable to be attacked by inflammation; the spine, for example, may become the seat of tubercle, syphilis, or osteoarthritis; the muscles may be attacked by rheumatism; gummata may develop in them (especially in the sternomastoid); or the sheaths of the nerves may become involved; but, with the exception of the cellular tissue and the lymphatic glands, separate description is not required.

DIFFUSE INFLAMMATION OF THE CELLULAR TISSUE

This is especially serious from the arrangement of the cervical fascia. It may be caused by poisoned wounds (either of the skin or the mucous surfaces); by infection through the blood-stream, as in pyæmia; or by extension from some neighbouring focus of disease, alveolar abscess for example, suppuration in the floor of the mouth following operation, tonsillar abscess, and especially the periglandular inflammation that occurs in scarlatina and diphtheria. The intense depression characteristic of these disorders, lowering the vitality and the power of resistance of the tissues, is probably the cause why it spreads with such rapidity and so widely.

The symptoms are very grave from the first: often there is a rigor; the temperature rises rapidly; the pulse is quick and feeble and delirium soon sets in. The pain is intense; the head is fixed; the tongue, if the submaxillary region is involved, forced up into the mouth; the jaws hardly able to move; and swallowing almost impossible. The skin is swollen and puffy; the superficial veins are distended, and all the tissues of the neck hard and tense. If left to itself, the fascia may yield and allow the exudation to make its way towards the surface and point by the side of the neck; but the inflammation is more likely to spread, involving one layer after another, until either the patient dies from acute blood-poisoning, or the mediastina are implicated, and pleurisy, pericarditis, or retrosternal suppuration is added to the rest.

Early and free incision is the only course. The patient should be placed under an anæsthetic; an incision, an inch and a half or two inches in length, made over the most prominent part of the swelling; the deep fascia divided to the same extent upon a director; and, if this does not give sufficient relief, the point of the director thrust into the middle of the swelling and followed up, after Hilton's method, with dressing-forceps. Afterwards a large drainage-tube should be inserted, and the discharge encouraged as much as possible. The direction of the incision must be parallel to that of the main vessels, and it must be very carefully made, as it is not always possible to ascertain how far they are displaced.

Even when the inflammation is not so severe as this, extensive destruction is by no means uncommon; and sometimes, especially after scarlatina, profuse hæmorrhage occurs about the time that the sloughs are separating. If it comes from the carotid or the jugular, an attempt must be made to find the bleeding point and isolate it for ligature, tracing it some little distance up or down, as the case may be, so as to get clear of the sloughing part; but if, as usually is the case, this is impossible, all that can be done is to apply styptics and pressure. The cavity must be cleansed and dried as thoroughly as possible, well covered with iodoform, and then plugged with iodoform gauze; but the prognosis is very grave.

INFLAMMATION OF THE LYMPHATIC GLANDS

The cervical glands are especially liable to attacks of inflammation. Eczema capitis in infancy, and the eruption of the teeth and affections o the throat in childhood and youth, maintain in many cases a certair degree of chronic hyperæmia. Usually this subsides when the cause is removed; but sometimes, before this can be done, other irritants make their appearance upon the scene, and find in the impoverished and weakened gland-tissue the soil that suits them best.

The pyogenic micrococci, for example, may gain access to them through abrasions of the mucous surface. If they are in sufficient number, or the tissue-resistance is sufficiently enfeebled, suppuration follows, without much energy or constitutional disturbance, if the general nutrition is good; but with the utmost virulence, leading to sloughing phagedæna, or diffuse cellulitis, if the vitality is depressed by any form of blood-poisoning, scarlatinal, diphtheritic, or septicæmic.

In other cases the tubercle-bacilli are the irritant, entering in the same way. The glands slowly enlarge, caseate in the centre, and then break down. The capsule gives way, the caseous fluid penetrates into the circumjacent cellular tissue, infecting it wherever it spreads, and at length, after travelling long distances in all directions under the deep fascia, it makes its way out through this at some point and discharges on the surface, leaving behind it typical scrofulous sinuses.

Syphilitic inflammation is characterised by the sudden enlargement of all the cervical glands at the same time, the onset of the secondary period. Suppuration is very rare, but complete resolution is often long delayed, and the least cause—mere exposure to a draught—is enough to bring back the swelling and make them tender and painful. Slight enlargement of this character is one of the most common causes of stiff-neck.

Other forms of specific inflammation, occurring in connection with leprosy, glanders, or actinomycosis are too rare to deserve special mention.

Diagnosis.—Acute inflammation rarely presents any difficulty; the pain, heat, and tenderness on pressure are sufficient to indicate what is taking place, although it is impossible to say whether the mischief is commencing in the gland itself, or, what is more frequent, in the cellular tissue around it. The distinction is not material, as in either case the treatment is the same: if, after the cause has been removed, the inflammation does not subside with rest and cold, if the swelling continues to increase, and particularly if the skin becomes œdematous, an incision must be made through the superficial structures and a director used to explore after Hilton's plan.

Chronic inflammation is distinguished by the lobulated chain-like character of the swelling, and seldom gives rise to any difficulty, except in the case of some of the varieties of lymphoma and lymphadenoma. Tubercular infiltration is marked by the slow, painless enlargement, involving one gland after another, and by the gradual softening and breaking-down; syphilitic disease by the firm hard outline, the retention of the natural shape, and the very slight tendency to infiltrate or adhere to the tissues around. The treatment, as detailed already, is entirely dependent upon the cause.

Torticollis

Wry-neck is due to irregular contraction of the muscles twisting the head. The sternomastoid is the one usually in fault, sometimes the only one, but the others and the cervical fascia often aggravate the evil. It may be primary, caused by disease of the muscle itself (this is usually distinguished as the congenital variety); or secondary, arising from inflammation of some of the structures near (the joints, vertebræ, lymphatic glands, &c.), or from a disordered condition of the nervous system.

(*a*) *Congenital torticollis* is rarely noticed until some time after birth. This arises partly from the shortness of an infant's neck, partly from the fact that the deformity itself is not nearly so well marked at this time of life as it is later. How it originates is uncertain. Probably it is due to partial rupture of the muscle at the time of parturition; at least a tender ovoid mass is not unfrequently found shortly after birth in the sternal head of the sternomastoid, just where the tendinous and muscular fibres meet, and in several cases wry-neck is known to have been present later in life.

The back of the head is drawn down; the chin is directed towards the opposite side, so that the face looks somewhat upwards; and the muscle itself stands out like a tense cord, with a hollow in front and behind. The sternal portion is usually the chief offender, and in bad cases the mastoid process may be dragged down so far as to lie immediately over and scarcely an inch from the sterno-clavicular articulation. As a result, the cervical vertebræ become twisted and deformed; secondary curves make their appearance in the back; the under side of the face does not grow in proportion to the rest; the line of the eyes becomes oblique; and, if the condition is not remedied before puberty, even the breast fails in its development.

If the deformity is detected in time, an attempt may be made to prevent it by massage and passive motion, but nearly always tenotomy is required sooner or later. The only rule is to divide everything that prevents the full range of movement, both heads of the sternomastoid nearly always, and very often the cervical fascia as well, taking care, however, to avoid injuring the great vessels of the neck, which are frequently displaced. An anæsthetic is always advisable. The assistant, as in other cases of tenotomy, should hold the head so that the bands are relaxed while the tenotome is being passed behind them, and tightened up when the blade is in position. Separate punctures should be made wherever necessary; the division of both heads of the muscle through one opening is only to be preferred when it is less dangerous than doing it through two; and a blunt-pointed tenotomy knife should always be used after the preliminary puncture has been made. The usual situation is about half an inch above the clavicle, but that spot should be selected at which the fibres stand out most distinctly, and the division should always be from behind forwards.

The little wounds should be sealed with iodoform or collodion, and the head brought as far as possible into a straight line at once. The extent to which this is possible depends partly upon the completeness of the division, partly upon the alteration in the cervical spine. If the patient is sufficiently old to appreciate the importance of the result, mechanical contrivances can usually be dispensed with: friction, shampooing, passive motion, carrying a weight in the hand, and, above all, the use of a looking-glass, generally suffice not only to secure the desired effect, but to prevent relapse. In the case of children, however, and where, owing to the altered shape of the vertebræ, there is fear of recurrence, it may be necessary either to make use of a spinal support with a jury-mast, so as to secure oblique traction, or, what is nearly as efficient when properly looked after, Little's arrangement of strapping. One broad band is fastened horizontally round the head; a second round the waist; and a strong webbing strap with a rubber accumulator attached behind the ear on the sound side and below in the opposite nipple line.

In old cases a second operation is often required to divide the bands of cervical fascia.

(*b*) *Acquired torticollis* may be due to rheumatism or exposure to cold, or it may be symptomatic of inflammation of the lymphatic glands, the vertebræ, or other structures in the neck, the muscles (for in this case the splenius and others are in a state of tonic spasm as well) contracting to save the affected part. In many of these cases the diagnosis of the exciting cause is exceedingly difficult, and very great care is required, as cervical caries is by no means uncommon. Tonic torticollis of this character can always be distinguished from the congenital variety by its relaxing completely under an anæsthetic, and by the absence of any shortening of the cervical fascia.

The other variety of acquired torticollis—that which occurs in connection with disease of the central nervous system—is seldom met with until late in life, and is distinguished by the clonic character of the convulsions. The head can only be kept at rest by means of some external support; as soon as it is left the muscles are seized with clonic spasms, which grow worse and worse as the patient attempts to control them. Sometimes one side only is affected; more frequently both, and in many instances other muscles as well. Massage, galvanism, counter-irritation, faradisation of the opposing groups, and many other remedies have been tried without much benefit. Occasionally relief is obtained by bromide of potash, but it seldom lasts long. Neurectomy of the spinal accessory holds out a better prospect when only the sternomastoid is involved, especially if a large portion of the nerve and its connections with the cervical plexus are removed; but in most instances the other muscles are affected as well.

Tumours of the Neck

A very large number of the tumours of the neck are of congenital origin, although they may not begin to enlarge or become prominent until late in life.

Nævoid growths are fairly common. In most cases they consist of nothing but dilated veins and capillaries (the so-called blood-cysts of the supraclavicular region); but, not unfrequently, they are associated with a variable amount of fibrous and fatty tissue, or with hydrocele of the neck—in all probability a similar affection of the lymphatics. They can usually be recognised by the effect of gentle pressure; but, if there is much solid tissue, or many phleboliths, and if the history is vague, the diagnosis is simply a matter of conjecture. The only satisfactory treatment is excision; but as they may extend long distances under the muscles (in one case of a mixed nævoid and lipomatous growth under my care, the supra-clavicular and subscapular regions were completely dissected), and, not unfrequently, communicate with the jugular veins, the operation should not be lightly undertaken.

Hydrocele of the neck, congenital cystic hygroma, or *lymphangeioma cysticum*, has already been described. It may be present at birth, or may not cause any conspicuous enlargement until adult life. Sometimes it occurs under the jaw, more frequently in the supraclavicular region, extending into the axilla. It may be unilocular (the term hydrocele of the neck is sometimes reserved for this) or composed of numbers of cysts of all sizes, mixed with fibrous or fatty tissue. Generally the fluid they contain is clear and serous, but it may be red, chocolate-brown, or green, according to the amount of blood mixed with it and the changes it has undergone. Naturally, therefore, the degree of translucency is very variable. These growths not unfrequently extend very deeply into the neck; they may pass the middle line, reach down into the thorax, surround the great vessels, and even extend upwards into the occipital region. Generally part of them is superficial and the diagnosis easy, but sometimes they are altogether buried behind the trachea or in the mediastinum, so that it is impossible to ascertain what their nature is. In some instances a fatal result has been caused by pressure upon important organs, in others it has followed from deep-seated suppuration; disappearance without operation is very unusual.

The treatment must be very cautious. Simple cysts may be tapped and drained, and the same thing may be done in the case of individual ones of larger growth; but, though this gives temporary relief, they often refill. Injections of iodine and setons have succeeded, but in many cases they have caused diffuse attacks of inflammation, and even death has occurred. Excision is only possible when the growth is small and superficial. Repeated incision and drainage, carefully avoiding suppuration, offer the best prospect.

Hyolingual cysts.—Another variety originates in connection with the hyolingual canal. This extends in the fœtus from the foramen cæcum to the hollow of the hyoid, and thence onwards to the pyramidal process of the thyroid body. Part is developed from the stomatodæum (the lingual portion probably only), part from the hypopharyngeal diverticulum around which the thyroid originates. In the infant the former often persists; the rest usually disappears or remains, as the levator glandulæ thyroideæ, the pyramidal lobe itself, the ligament extending from it, or the cysts that are so frequently developed near its apex. Some of the cysts that are formed from this are dermoid, containing sebaceous matter and hair (the lingual canal itself is epiblastic); others are simple and unilocular, filled with serum; in others, again, papillomatous and villous growths make their appearance (these are usually regarded as accessory thyroids, and may occur in the larynx and trachea), and sometimes, again, they undergo malignant degeneration, and pass into a form of cystic epithelioma.

Branchial cysts.—Congenital cysts, growing down to and involving the sheath of the great vessels, may develop from the lining of the branchial clefts at the side of the neck. Sometimes they are associated with branchial fistula. Their contents (they may be sebaceous or mucous) vary according to the character of the epithelium from which they spring.

In addition to these growths of congenital origin, tumours of all kinds originate in connection with the various tissues and structures in the neck. Sarcoma, lipoma, fibroma, and even enchondroma, may develop in the cellular or fibrous tissue (the last-named possibly from rudiments of the branchial cartilages); exostoses, enchondromata, and myeloid sarcomata from the bones; fusiform and sacculated aneurysms, arterio-venous aneurysm and aneurysmal varix, from the vessels; and molluscum, sebaceous cysts, papilloma, and epithelioma from the skin.

The lymphatic glands present still greater variety. In addition to lymphoma, lymphadenoma, and sarcoma (growths originating in them), and to the various forms of specific inflammation (tubercle, syphilis, glanders, leprosy, &c.), which affect them and cause them to enlarge to such an extent that they are often designated tumours (in spite of their inflammatory origin), they are liable to be the seat of secondary malignant growths of all kinds. Epithelioma of the lip and tongue affect the submaxillary ones; sarcoma of the tonsil, those along the carotid sheath; scirrhus of the breast, the supraclavicular chain; and epithelioma of the œsophagus, the deeper ones that run down to the mediastinum. Carcinoma of the larynx, on the other hand, does not extend to them until late in the course of the disease. Epitheliomatous glands in the neck, especially behind the angle of the jaw, are peculiar in often becoming cystic, the central mass undergoing caseation and liquefaction. When this occurs they increase rapidly in size, the skin over them becomes red and thin, and, not unfrequently, they burst and give way, discharging a mixture of caseous débris, blood, and serum. Sometimes the hæmorrhage is very serious.

Tumours in connection with the thyroid body (which are described separately) are distinguished by their rising and falling with the trachea in deglutition. *Bursal cysts*, which may occur over the thyroid cartilage, or the thyrohyoid membrane, are known by their chronic character, by the age at which they occur, and by the thinness of their walls and the character of their contents.

Hernia of the pharynx (*pharyngocele*) or œsophagus (a protrusion of the mucous membrane through a defective portion of the wall, causing a great sac to develop behind the carotid vessels) may be diagnosed by its position, the variation in its size from time to time, and the passage of a sound. It may be congenital or acquired; but if it gives rise to inconvenience, the only course is to excise it. *Tracheocele* (a similar protrusion between the cartilages of the larynx or trachea) is distinguished by its containing air, and by the variation in its size on forced expiration; usually it projects in front.

Gummata may occur in the muscles, especially the sternomastoid, or masses of bone may develop in them as a result of osteoarthritis, or after strains. The sternomastoid induration of infants is probably traumatic, due to partial rupture and coagulation of the blood inside the sheath.

Operations on the Air-Passages

Laryngotomy is performed in the cricothyroid space. It is not suitable for children, and only for adults in cases of emergency or when a tube has to be used for a short time, during an operation for example. The space is much too small (unless the cricothyroid and lateral crico-arytenoid muscles are incised) to admit of the removal of a foreign body or a papilloma.

The question of an anæsthetic depends upon the urgency of the operation. The patient's head is thrown back as far as possible, while the neck rests upon a firm support, and the cricothyroid space identified. A longitudinal incision is made exactly in the middle line over this, and the larynx opened by dividing the membrane transversely immediately above the cricoid cartilage. The cricothyroid arteries are seldom injured, but if there is any hæmorrhage the bleeding points can be secured at once with Wells' forceps. A laryngeal cannula, which is shorter than an ordinary tracheal one and flattened from above downwards, can then be fitted in at once.

Tracheotomy is required much more frequently. It may be performed for the relief of obstruction, whether it is temporary (as in croup, diphtheria, œdema of the glottis, or muscular spasm) or permanent (as in syphilitic stenosis); for the removal of foreign bodies; to give rest to the larynx in cases of painful ulceration; or as a precaution in operations in order to prevent the entry of blood.

The trachea may be opened either above or below the isthmus of the thyroid; but, unless there is some special indication to the contrary, the former should always be selected. The anterior jugular and inferior thyroid veins are in close relation with the lower part. The innominate artery bifurcates almost on it, and sometimes reaches far up into the neck. The thyroidea ima may cross it. It lies very much farther from the surface, and is much more easily displaced to one side. In infants, too, the thymus may cause a certain amount of difficulty.

Except in cases of great emergency, an anæsthetic should always be given. Chloroform is better than ether, as it is less irritating: very little is required, especially in the case of children, as it is not necessary to induce absolute anæsthesia. The recumbent position is the most convenient, the head, if the breathing will allow it, being thrown back, and the neck supported by a small but firm pillow or sand-bag. As there is sometimes a little difficulty in identifying the cricoid cartilage, a careful examination must always be made first.

The incision must be two inches in length, beginning on the margin of the cricoid cartilage (unless it is wished to include this, as in laryngo-tracheotomy), dividing the skin and exposing the anterior layer of the deep fascia. If the assistant holds the head perfectly straight and the surgeon's hand is a light one, there is no need to fix the trachea yet. The skin can be made sufficiently tense by drawing it down upon the sternum. The next step is to identify the white line that marks the interval between the muscles. At this level they are not in contact, and the only structure in front of the trachea (with the exception of veins) is the cervical fascia that passes across from one to the other. To see this clearly the edges of the incision must be gently separated with the forefinger and thumb of the left hand, steadying the trachea without compressing it. Retractors held by an assistant nearly always displace it.

The next proceeding varies according to the operator. Careful dissection with a scalpel until the rings of the trachea are thoroughly exposed used to be the invariable rule, but now there are many modifications. Whitehead advocates splitting the fascia from above downwards with a raspatory (even a steel director may tear the veins) until the isthmus is reached. This is pushed down, and the trachea laid bare at once. Parker only makes two incisions, one to expose the white line, the other from below upwards through it into the trachea. Bose recommends a transverse incision through the fascia on the cricoid cartilage; a blunt hook is then introduced into the slit and passed down behind the thyroid, and everything that lies in front pulled towards the sternum until the first three rings are exposed. This has been called the bloodless method, and may be practised when there is a large plexus of distended veins, so placed that it would be difficult to avoid injuring them in any other way.

Parker's method undoubtedly shortens the operation, avoids shock, and lessens the size of the wound and the absorbing surface (a matter of great moment), but it can hardly be recommended unless the operator is thoroughly experienced. In actual practice each case must be judged upon its own merits: in some, it may be advisable to open the trachea at once; occasionally it must be done, as respiration may cease with the shock caused by the first incision; but in all alike it is necessary to expose and recognise the interval between the muscles, to keep exactly in the middle line, to avoid wounding the veins, and to make the deep incision from below upwards. Undoubtedly it is safer not to open the trachea until it is thoroughly exposed; and this should be the rule; but, on the other hand, tedious dissection is equally to be avoided.

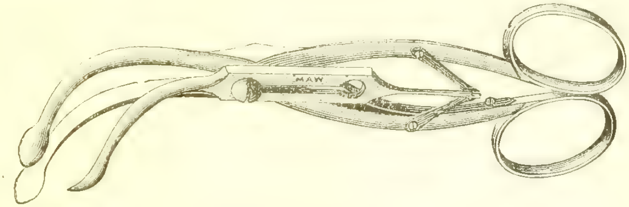

FIG. 335.—Trachea-dilator.

The isthmus of the thyroid gives very little trouble: it can be pressed up or down by the finger without difficulty. Great care must be taken to open the trachea exactly in the middle line. The upper three rings should be divided, but not the cricoid. As soon as this is done the edges of the tracheal wound should be held open with dilating-forceps until the immediate disturbance consequent on the change of breathing has subsided. Sometimes respiration ceases altogether, the abundant supply of oxygen causing apnœa.

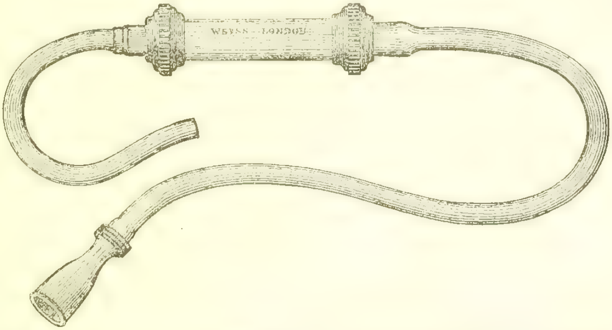

FIG. 336.—Parker's suction apparatus. The cylinder is filled with antiseptic cotton-wool.

Sometimes rapid expiratory efforts are made: coughing, of course, is impossible. In cases of croup or diphtheria advantage may be taken of this to clear out any false membrane that can be seen. Parker recommends sweeping round the interior of the windpipe with a feather dipped in a solution of soda or borax in order to detach and bring away as much as possible; and, if this does not succeed, suction either by means of a ball-aspirator or a properly guarded mouth-tube (fig. 336). The immediate application of the mouth to the wound must be absolutely condemned.

The size of the trachea differs even at the same age, and this of course determines the diameter of the cannula; its shape must depend upon the part of the windpipe opened. Durham's and Parker's (figs. 337 and 338) are the most satisfactory; the latter, however, owing to the absence of a guide, is occasionally a little difficult to introduce. Quarter-circle and bivalve tubes should never be used. Morrant Baker's rubber ones answer exceedingly well when the wound has assumed a definite shape, the amount of discharge often beginning to diminish at once. In most cases a double tube is necessary for purposes of cleansing (Parker dispenses with it when there is a well-trained nurse), and the inner one should project slightly beyond the outer, so that the latter may not become clogged. In addition, the collar of the tube should be movable, that it may accommodate itself to the action of the trachea in swallowing.

There need not be any hurry about the introduction of the tube; the wound can be held open with dilating-forceps for a minute or two; the trachea thoroughly cleared; search made for a foreign body (in this case it is sometimes advisable to fix the edge of the trachea temporarily to the skin); or a suture passed through the lower part of the wound ready to fasten. Then the cannula may be quietly introduced on a pilot, if its construction admits of it, and, the guide being withdrawn, secured by means of a tape round the neck. In this way there is no fear either of passing the tube between the trachea and the fascia or of leaving it in its proper position, but blocked with false membrane.

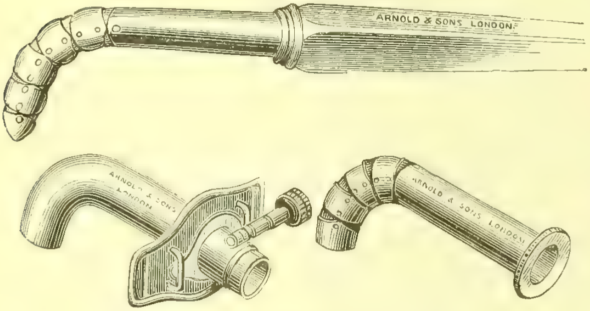

FIG. 337.—Durham's cannula with pilot.

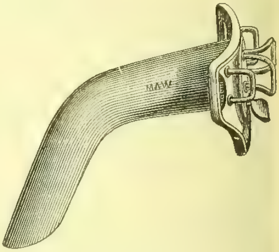

FIG. 338.—Parker's cannula.

No operation in surgery is so frequently bungled as tracheotomy; easy as it appears on the dead subject, on a child with a short fat neck, suffering from extreme dyspnœa, it is entirely different. Waste of time should, of course, never be permitted, but hurry is a great deal worse. The cricoid cartilage has been mistaken; the trachea pushed to one side and missed altogether (it is very easy in a child); the opening hacked or made on one side; the posterior wall cut into; important veins wounded, and the carotid, the innominate, and even the sac of an aneurysm laid open. This cannot happen if the head is held straight, the incision made of sufficient length and exactly in the middle line, and if the operator feels from time to time what he is doing. If after the first incision he presses the skin on either side backwards with his thumb and forefinger, the trachea is fixed in the middle between them without being compressed, and is kept well up in the wound.

Hæmorrhage occasionally is unavoidable. If an artery is cut its end should be clamped at once, and a large vein may be treated in the same way. Generally, however, the source cannot be detected; it comes from the small vessels of the plexus between the layers of the fascia, all of which are distended owing to the dyspnœa. In these circumstances it is often advisable not to wait, but to open the trachea at once; as air enters and the right side of the heart becomes relieved, the veins empty themselves and the hæmorrhage ceases. Holding the trachea slightly forwards with the dilating-forceps helps to compress them and prevents the blood entering the lungs.

When tracheotomy is performed as a precautionary measure to prevent the entry of blood into the lungs during the course of an operation, the incision and the various steps are the same, but a tampon is inserted instead of a simple tracheotomy-tube. The two best known are Trendelenberg's and Hahn's. Each consists of a tracheal tube; but in the former a dilatable rubber collar is used to block the space around it, between it and the mucous membrane; in the latter compressed sponge. Of the two this appears to be the better; it is not so likely to slip or give way; but in all operations, except those on the larynx itself, a simple tracheotomy-tube with a sponge (attached to a string), to block the upper aperture of the larynx, answers equally well, and is not nearly so likely to get out of order.

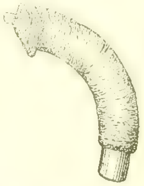

FIG. 339.—Hahn's tampon cannula covered with compressed sponge impregnated with iodoform.

After-treatment.—This varies naturally with the cause; it must always be remembered that tracheotomy only relieves a symptom or prevents one; the original trouble still remains.

(*a*) In the simplest case—chronic laryngeal stenosis, for instance, in which there is no pulmonary complication—all that is needed, provided the tube fits, is something to warm and moisten the air before it enters the lungs, and a dry absorbent dressing around the orifice to diminish the amount of discharge and lessen the risk of broncho-pneumonia and cellulitis. The patient should be kept as quiet as possible in a semi-recumbent position, and well protected from draughts. A bronchitis-kettle may be used; but it is better, for a time at least, to protect the orifice with a thin flat sponge wrung out of hot water so as to filter the air thoroughly. The wound should be powdered with iodoform, and the flanges of the cannula prevented from pressing upon it by little pads of absorbent wool. The frequency with which the tube requires changing depends upon the amount of irritation it causes; a rubber one can often be introduced on a proper dilator by the second day. In cases such as these, there is very little of that tenacious mucus which is so troublesome in croup or diphtheria.

For the first few days the patient should be fed through the rectum; the movements of the trachea in swallowing are very painful (cocaine sprayed over the wound prevents this to some extent); and there is great risk of fluid trickling down the larynx and passing by the side of the tube into the lungs. This may happen even after the cannula has been removed, if the larynx has not thoroughly recovered, but usually there is no danger after the wound has healed and the patient has grown accustomed to the change of respiration and learnt how to cough. If the rectum becomes irritable or thirst is distressing, an œsophageal tube should be used instead.

Tracheotomy-tubes, if worn permanently, should be frequently changed and carefully inspected from time to time. Their duration of life varies very much, and instances have been known of their breaking and of the end falling down into the bronchi. It is always as well to protect the orifice with a suitable respirator.

(*b*) In diphtheria the after-treatment requires even greater care. The air must be warmed and moistened, and the cot surrounded by screens, but the top should be left open. The tube must be kept clean by means of feathers dipped in a solution of bicarbonate of soda or potash (soda bicarb. gr. xx ; glycerini ʒss. ; aq. ad ℥j), and if there is any membrane heard or seen floating in the trachea or larynx it must be cleared away in the same manner. Parker recommends that the solution should be sprayed from time to time over the wound to prevent the viscid mucus collecting and drying around the orifice. The frequency with which the inner cannula requires changing depends upon the success with which this is carried out. At first it may need it almost every hour, but it must be remembered that the process is an exhausting one, and, for a time, very alarming to a child, so that every endeavour must be made to keep the passage free without. Each cannula should have a double set of inner tubes, so that when one is removed and a feather has been passed down the outer to make sure it is clear, the second can be introduced without delay. The outer need only be removed once a day. To clear them they should be placed in a hot solution of soda and well scrubbed.

How long the tube should be continued depends upon the course of the disease ; but, in any case, the metal cannula should be replaced as soon as possible by a rubber one (it can usually be done by the third or fourth day) and this should not be worn longer than is absolutely necessary. Before leaving it off an attempt must be made to educate the larynx again and to reduce the amount of air passing through the tube, by using one that is perforated on the convexity or very much shortened. The child, of course, must be watched night and day by some one who can use dilating-forceps and replace the cannula at once if there is any real danger.

Instances of very great difficulty are met with every now and then ; dyspnœa comes on as soon as the tube is removed, and the child seems absolutely unable to breathe through its larynx. In a few cases this is due to a mechanical impediment, cicatricial stenosis, or the growth of granulations from the mucous membrane, caused by the irritation of the cannula ; but in the majority no reason of this kind can be found, nor can more than a small proportion be accounted for on the hypothesis of diphtheritic paralysis. Probably it arises not so much from any structural alteration as from the inability of the child to direct its efforts with sufficient energy, and from actual fright. Most cases recover as the child grows stronger by patiently trying again and again ; sometimes galvanism is of service, but in a few nothing succeeds, and, then, if no organic obstruction can be found, the only course left is intubation—passing a tube into the larynx, through the mouth, or through the wound, and retaining it there. Either O'Dwyer's or McEwen's can be used ; the essential point is that the lower end should be just below the level of the tracheal opening. A tube of this kind can be left without being removed for twenty-four hours or longer ; but if it becomes blocked, so that it cannot be cleared by coughing, or if symptoms of exhaustion come on owing to the distress it causes, it must be removed at once, and under no circumstances may the child be left alone for a moment.

Prognosis.—Care must be taken to distinguish between the consequences of the operation and those of the disease for which it is performed. Much depends upon the age of the patient ; in an infant it is always serious, the structures involved are so small and delicate, and there is such great risk of pulmonary complications, independently of croup or diphtheria. If the lungs are already collapsed and partially consolidated, if the patient is exhausted by prolonged battling against imminent asphyxia, or if he is dying from the diphtheritic poison, the operation can do no good; it must not be blamed for the result, but it may hasten the end. If it is to be of any real service, or if the wound is to be used not merely to relieve a symptom but to attack the disease by removing false membrane and giving the patient pure air, not that which has been befouled by passing over a poisoned surface, it must be performed while there is still a reasonable hope.

Inflammation of the cellular tissue of the neck is the most common complication. There is always a little at the first, causing a certain amount of swelling and œdema around the wound, but it is seldom serious unless the parts have been much disturbed in the operation or the vitality of the tissues is greatly impaired. Usually it subsides in the course of a few days; sometimes, however, it forms an abscess around the trachea (especially if the tube has missed the opening when it was being introduced), and occasionally it leads to diffuse suppuration, which may even spread down to the mediastina and involve the pleura or pericardium. Care must be taken that the tape fastening the cannula is not too tight.

Irritation of the mucous membrane of the trachea may be caused by the end of the cannula. Usually this is due to the fact that it does not fit. Ulceration of the anterior wall, leading to perforation, was a common result when quarter-circle tubes were used, and though this is much more rare at the present time, masses of granulations due to the constant friction of the end, are not unfrequent. Slight cases, if the growth is easily accessible, may be relieved by means of an alum spray, or by painting it with an astringent solution; more severe ones may require an enlargement of the wound and the application of the cautery or a curette. In a few very rare instances the trachea remains irritable, even when a rubber tube is worn, without any perceptible cause.

Diphtheria very seldom attacks the wound. It may become foul and sloughy from the constant irritation, but it is rare to find a definite adherent membrane. If it forms it must be destroyed at once.

Emphysema is sometimes met with, especially when the cervical fascia is opened up irregularly, and it is said that the air may spread in the tissues until it reaches and fills the pleura.

In addition to these there is always the risk of bronchitis and bronchopneumonia, caused by the entry of cold or dry air, foreign bodies, dust, food, blood, or the secretion of the wound; and, of course, all the ordinary complications of irritated wounds, such as sloughing, erysipelas, &c., may occur as well.

Laryngo-tracheotomy.—In this operation the cricoid is divided as well as the upper rings of the trachea. It may be required in the case of children with very short necks, or be advisable when there is a growth or a foreign body in the larynx. Under other circumstances it should not be performed, as it is liable to lead to serious impairment of the voice.

Subhyoid pharyngotomy (opening the pharynx through the thyrohyoid membrane) has been performed for the removal of growths and foreign bodies in the larynx. It should only be resorted to in cases in which extraction by the aid of the laryngoscope has failed or is unsuitable.

Thyrotomy.—Median longitudinal division of the thyroid cartilage may be required under similar circumstances. Laryngo-tracheotomy is performed first and a tracheal tube inserted; in the case of papillomata, which are often very vascular, a tampon is advisable to prevent any blood trickling down the trachea. In some cases this, or the division of the cricothyroid membrane, is sufficient; if not, the incision is carried upwards and the two halves of the thyroid cartilage separated. The greatest care must be taken to keep exactly in the middle line, and if possible avoid wounding the anterior commissure of the cords. In children and young adults the incision may be made with a scalpel, and it may not be necessary to divide the whole length; the elasticity of the parts is so great that sufficient room can be obtained without. In old people this is not possible, and in many instances a fine saw must be used. After the growths have been removed and the base from which they spring seared with chromic acid, the margins of the cartilage must be accurately adjusted and secured with wire sutures passed through the perichondrium. The tracheal tube should be left for some days, until all danger of inflammation is past and the parts are fairly well united. The patient must in the meanwhile be kept perfectly quiet; talking, and especially coughing, prevented as far as possible; and all sources of irritation avoided. The voice is very likely to be impaired: not, perhaps, so much from inaccurate adjustment as from the subsequent cicatrisation and contraction.

Intubation of the Larynx

This method of treating temporary occlusion of the glottis has recently been revived by MacEwen (for adults) and O'Dwyer. The former employs long cylindrical tubes after the pattern of gum-elastic catheters, introducing them through the mouth and changing them every twelve hours; the latter much shorter ones, which (if not coughed up) may be left *in situ* for a fortnight, resting upon the ventricular bands without passing through. The shortest are an inch and a half in length; the longest three. At the upper end is a diamond-shaped head flattened in front and provided with a small eye to carry a thread. Below is a neck which expands into a fusiform enlargement. Each tube is provided with a jointed guide, which can be screwed on to an introducer. This consists of a stem set on a handle and carrying a sliding tube, so arranged that when the cannula is in position it can be pushed off the guide and left as the latter is withdrawn. Finally, there is an extractor for the purpose of getting the cannula out again. The cannulæ and guides are made in five sizes, the smallest being suitable for a child under two years of age.

The child must be well wrapped up in a blanket and held by a nurse in a sitting position on her lap, so that the occiput rests against her left shoulder. The assistant stands behind and steadies the child's head. A suitable tube is selected, threaded with a long loop of silk, and fitted on a guide. This is then screwed on to the introducer and a gag placed in the mouth on the left side. The operator now hooks the loop attached to the tube round the little finger of his left hand, and passes the index finger over the tongue on to the epiglottis, following it up closely with the end of the tube in his right. Then he either simply hooks the epiglottis forward, and slips the tube over it, when, if suddenly turned down and kept in the middle line it must pass into the larynx; or he passes over it on to the arytenoid cartilages and guides the cannula in. In either case it must follow the palmar surface and glide in under the tip. The moment it is in position, the sliding tube should be shot forwards, the guide drawn back, and the cannula pushed on with the finger. The object of the loop of silk is to withdraw it, should it have missed the proper opening or passed into the pharynx.

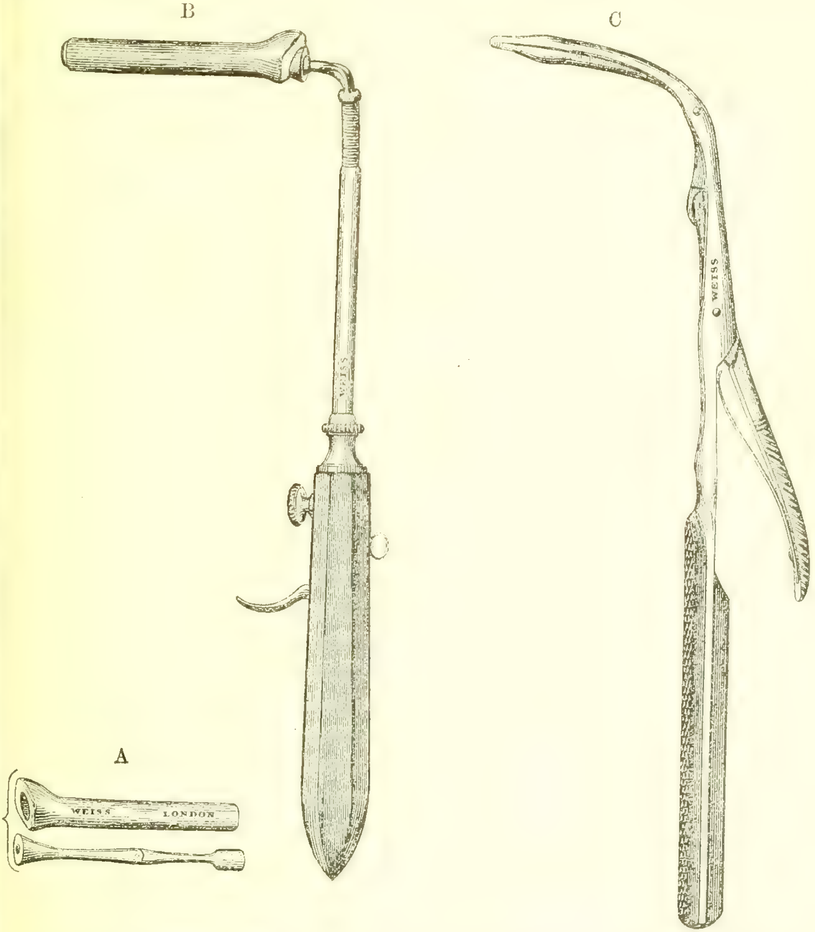

Fig. 340.—O'Dwyer's tubes. A. Laryngeal cannula with jointed guide. B. Introducer with guide screwed on and cannula, ready for introduction. C. Extractor with jaws (serrated on their outer surfaces) closed.

The immediate effect is a violent fit of coughing, during which a large amount of ropy mucus is expectorated. As soon as this ceases the loop may be cut, the silk drawn out (taking care not to displace anything) and the tube left.

Extraction is more difficult and may require an anæsthetic. The forceps are introduced closed, and the jaws separated from each other by touching a lever. The serrations are on the outer surface, so that there is no difficulty in holding the tube if it is once grasped.

In America intubation has apparently met with great success; those who advocate it affirm that there is no shock or hæmorrhage, and that the relief is complete. In England, so far, very few cases are on record, and its merits in different diseases are not accurately known. In acute œdematous laryngitis, whether arising from scald of the glottis or other causes, it is probably preferable to tracheotomy; and after tracheotomy, when the tube cannot be dispensed with, a laryngeal cannula has on several occasions been used with advantage; but whether it can take the place of tracheotomy in diphtheria is very doubtful.

The operation is certainly not so easy; in practised hands the introduction or removal of a laryngeal cannula may not be of much moment, even under circumstances such as these; but it would be almost impossible to those who have not had recent experience in manipulation. The larynx itself seems to tolerate the tube very well; they have been worn a fortnight without any ill consequence; nor is there any tendency for them to slip down, though they are often coughed up. It is a distinct drawback that they cannot be replaced by a nurse. It is said that the discharge from the trachea is freely coughed up through them, in spite of their narrow calibre. On the other hand, feeding a child is very difficult. An œsophageal tube may be tried, or the patient may be laid upon his back with the head hanging well down (so that everything falls of its own weight over the upper aperture of the larynx); but neither of these proceedings is easy, and in a large proportion of cases fluids find their way down by the side of the cannula into the lungs and set up broncho-pneumonia. Moreover, there is great risk that the cannula may force down some membrane in front of it, and block the trachea at once; and this is so important that even those who recommend intubation advise that the tracheotomy instruments should be immediately at hand. If intubation is to be employed in cases in which parents refuse their consent to tracheotomy, this is a matter of serious moment. Finally, it does not allow the trachea or larynx to be cleared in any way except by the natural efforts at expulsion through the narrowed opening.

EXCISION OF THE LARYNX

Excision of the larynx may be complete or partial. The former implies the removal of the whole of the cartilages, with sometimes part of the trachea, pharynx, hyoid bone, and circumjacent structures, and, with rare exceptions, is the only measure that can be adopted in the case of malignant growths of extrinsic origin. The latter aims merely at removing the seat of disease, and is only applicable to intrinsic tumours, that is to say, those springing from the vocal cords, true or false, and the parts immediately around them.

Excision has been performed for obstinately recurring and extensive papillomata, for lupus, perichondritis, and even for stenosis; but with very few exceptions, too few to take into consideration, it is never called for except in the case of malignant disease. In sarcoma it has proved fairly successful; in epithelioma, on the other hand, total extirpation is exceedingly fatal, in great measure from the direct effect of the operation. Partial excision, however, shows a much better result, and it seems probable, as the importance of the early diagnosis and early removal of carcinoma is more widely recognised, it will become better still. In other words, in extrinsic malignant disease, with very few exceptions, only palliative measures are advisable; and the same must be said of those cases of intrinsic disease in which the growth has advanced so far as to render complete extirpation necessary; with tracheotomy, cocaine, and morphia, the remainder of the patient's life must be made as tolerable as possible; the chance of his surviving such an extensive operation is too small to justify its performance; and even if it were successful, recurrence in such advanced disease is almost certain. Limited intrinsic growths, on the other hand, should be removed freely and without delay.

With regard to the diagnosis of the character of an intra-laryngeal growth, it has been pointed out by Semon that, if in the case of a person who has passed the age of thirty-five, a small warty growth makes its appearance upon one of the vocal cords, causing hoarseness or aphonia; if the cord to which it is attached becomes congested at an early period, and still more if its mobility is impaired; if there are signs of irritation around; or if the growth reappears very soon after partial or total destruction—it becomes at once the object of grave suspicion. It is the peculiarly limited character of intralaryngeal carcinoma in its earlier stages that renders the diagnosis of malignant disease so difficult and at the same time so important. Moreover, it must always be remembered that if the result of the microscopic examination of a fragment is negative it proves nothing, so far as the presence of malignant disease is concerned.

(*a*) *Complete Excision*

Preliminary tracheotomy, to prevent the entry of blood, is advisable, though it has not always been performed. By keeping close to the cartilages and by operating with the patient's head hanging down, this complication can be avoided until the trachea has been divided and a full-sized tube inserted. In any case the external portion of the cannula should be bent down by the side of the neck, and should be long enough to admit of an anæsthetic being given without inconvenience to the operator. If the disease is far advanced and the patient exhausted from dyspnœa, the tracheotomy should be performed a week at least before; if, on the other hand, the disease is limited, it should be done at the same time and the same incision made use of.

The patient may either be placed in the ordinary position, the incision being made from above downwards; or the dorsal spine may be so raised that the head is dependent and the separation from the trachea effected first. The latter is certainly preferable if a tampon is not used.

The incision runs vertically down the middle line from the hyoid to the second ring of the trachea. A transverse one is usually required as well. The soft parts over the cartilages are detached on either side, lifting up the perichondrium from them by means of a raspatory or a pair of blunt-pointed scissors, and the separation carried back, first on one side and then on the other, until the constrictors are reached, the superior laryngeal artery being secured by a double ligature and divided between. The trachea is then separated from the cricoid cartilage and carefully stitched to the skin, the tampon being removed and a large tube of vulcanite or lead inserted in its place. The larynx is drawn forwards from below, and the separation from the œsophagus and pharynx behind carried gradually upwards, leaving, if possible, the mucous membrane that lines them untouched. The thyrohyoid membrane is then divided, the condition of the epiglottis examined, and the separation completed.

The operation naturally requires numerous modifications. Enlarged glands may have to be dissected out, necessitating removal of the soft structures outside the larynx too; portions of the lateral and anterior parts of the pharynx may be involved; the whole of the epiglottis and part of the hyoid bone may have to be taken away; or, on the other hand, it may be possible on one side or both to leave the cornua of the thyroid cartilage; it is recommended to do this at the time of the operation, and if necessary dissect them out afterwards, as it lessens the risk of hæmorrhage. Opinions as to the propriety of leaving the cricoid are divided: according to Hahn it is better removed, as it interferes with deglutition.

All bleeding points are then secured; the cut edges of the pharynx sutured to the skin, and the cavity thoroughly packed with an absorbent dressing covered with iodoform. When the wound is sound an artificial larynx (either Gussenbauer's or Irvine's modification) may be introduced. Deglutition, if the pharynx has not been opened, is very satisfactory; if, however, it has been necessary to remove much of the anterior wall, so that the wound cannot close, an œsophageal tube will be required for the rest of life.

(*b*) *Partial Excision*

This operation naturally varies in its details even more than the former. There are, however, two well-characterised methods—the unilateral and the subchondral.

(1) Unilateral excision is performed in the same way and with the same precautions as the complete, but the transverse incision (which runs along the lower border of the hyoid) is, of course, only on one side. Half the hyoid and the epiglottis may be removed, but if possible the superior cornu of the thyroid should be left. The condition of the patient after a partial operation such as this is much more satisfactory; deglutition is not interfered with, and very fair power over the voice is regained.

(2) Subchondral excision has been proposed by Butlin, on the ground that malignant growths only involve cartilage very slowly, and that it would be possible in early cases to open the larynx and remove the whole of the diseased part with sufficient freedom without destroying or even seriously interfering with the framework.

CHAPTER XV

DISEASES OF THE THYROID

The thyroid gland consists of a number of separate sacs lined with a single layer of nucleated cubical cells, and surrounded by exceedingly vascular adenoid tissue. Colloid degeneration, affecting the contents of the sacs and attended with atrophy of the cellular lining, is of such common occurrence as almost to be considered normal. Nothing is known with regard to its function beyond the general fact that the activity of growth and nutrition of all parts of the body (including the brain) is intimately connected with its integrity. In women it frequently enlarges and becomes tender—at puberty, during the menstrual period, and during pregnancy. Cretinism is, in all probability, due to its imperfect development; removal during childhood causes a similar condition; and, in a large proportion of cases, is followed by myxœdema, if performed on adults. The temperature falls; the oxygenating capacity of the blood diminishes; leucocytosis sets in; the coagulability is lessened; the skin and subcutaneous tissue undergo a peculiar transformation; nervous symptoms (tremors, paresis, paræsthesia, &c.) make their appearance; and, at length, a cretinoid condition, with imbecility and coma, follows. When this does not take place, it is probably owing to the fact that the whole gland has not been removed, or that accessory thyroids (which are of very common occurrence) have undergone compensative hypertrophy. Sometimes it follows with great rapidity shortly after the operation; sometimes, on the other hand, slowly and gradually. In a few instances the immediate onset, after a period of apparently perfect health, has been brought on by exposure to cold.

Inflammation of the Thyroid

Inflammation may be acute or chronic, and end in resolution or in suppuration and sloughing, according to the cause and the addition or not of pyogenic irritants.

The symptoms, when the attack is acute, are very alarming, often beginning with a rigor and high fever. Owing to the way in which the gland is bound down by the cervical fascia, the pain is very severe; the tissues of the neck are hard and rigid, the superficial veins distended, the trachea and œsophagus compressed against the spine, and even cerebral symptoms caused by the obstruction to the cranial circulation. In most cases resolution sets in after forty-eight hours, and the acute symptoms begin to subside, but often the improvement is only partial; the diffuse enlargement disappears, but one or more local swellings remain; the skin becomes red and œdematous, and, at length, fluctuation is apparent. Death may occur from pressure upon the trachea, from pus finding its way down into the lungs, or from pyæmia or septicæmia. In one or two instances the gland has sloughed.

The treatment must be energetic. At the first onset aconite or antimony may be given internally in small, frequently repeated doses, until a distinct effect is produced upon the arterial tension. Ice-cold compresses should be placed upon the neck, the superficial veins pricked to relieve the circulation, and leeches applied to the supra-clavicular region. Venesection (either from the arm or the external jugular) may be advisable if the patient is young and the inflammation sthenic. If signs of suppuration make their appearance the superficial structures must be carefully divided layer by layer, and a director used for exploration after Hilton's method. A drainage-tube must be inserted to prevent the opening becoming valvular.

Simple Enlargement, or Goître

All forms of enlargement of the thyroid that are not the result of inflammation or malignant disease are grouped together as *goître.* The blood-vessels only may be affected, and the change limited to the gland (*pulsating bronchocele*); or this may be associated with other symptoms referable to the vascular system (*exophthalmic goître*, or Graves' disease). The vesicles or the interstitial connective tissue, or both together, may be hypertrophied without any change in structure and without any considerable alteration in proportion (*parenchymatous* or *follicular enlargement*). This may be complicated by various forms of degeneration. The follicles may enlarge into colloid cysts, while the interstitial tissue atrophies and wastes until neighbouring cavities fuse together and form huge, irregular spaces (*cystic goître*). Sometimes the contents remain clear and gelatinous; sometimes they become blood-stained and mixed with débris from the walls and vessels, until scarcely a trace of the original character is left. In many cases proliferating villous growths, consisting almost entirely of blood-vessels with a thin layer of epithelium over them, make their appearance, springing from the inner wall of the vesicles, and filling them with a soft, almost erectile mass. In others the fibrous tissue is the part chiefly affected; diffuse or localised bands are developed in all directions among the vesicles, and grow larger and harder until the whole structure becomes solid (*fibrous goître*). Finally, in most, the degeneration is not limited to any one tissue, but involves them all in varying proportion, so that masses of soft, vascular, interstitial substance, vesicles, cysts with all kinds of contents, and dense fibrous tissue are mixed up together and rendered still more complex by calcareous degeneration of the walls and capsule.

An attempt has been made to distinguish simple hypertrophy from adenoma, reserving the latter for those cases in which there are either distinct separate tumours or isolated portions growing out in an atypical form; but it is very doubtful if this can be maintained. A few cases are recorded in which secondary growths, pulsating and resembling the normal thyroid in structure, have occurred in the bones of the skull and other parts of the body. In some of these an apparently simple goître was present; but in others there was scarcely any increase in size.

Symptoms.—These depend upon the nature and rapidity of the enlargement. Certain features are, however, common to all alike.

The swelling may involve the whole gland and accurately follow its shape, or it may be confined to one side, or to the isthmus; but, whatever part it involves, it always moves up and down with the larynx in swallowing.

This is due to the arrangement of the cervical fascia, and is the distinctive feature of thyroid tumours. They may be smooth and uniform in outline, or covered with irregular bosses, or pedunculated and hanging by a stalk over the sternum. Sometimes the enlargement consists almost entirely of vessels or of cysts filled with masses of vascular outgrowths, so that the swelling is soft and elastic and pulsates almost like an aneurysm, with, in many cases, a thrill. Sometimes, on the other hand, only the fibrous tissue is concerned and the tumour is nodular, dense, and firm.

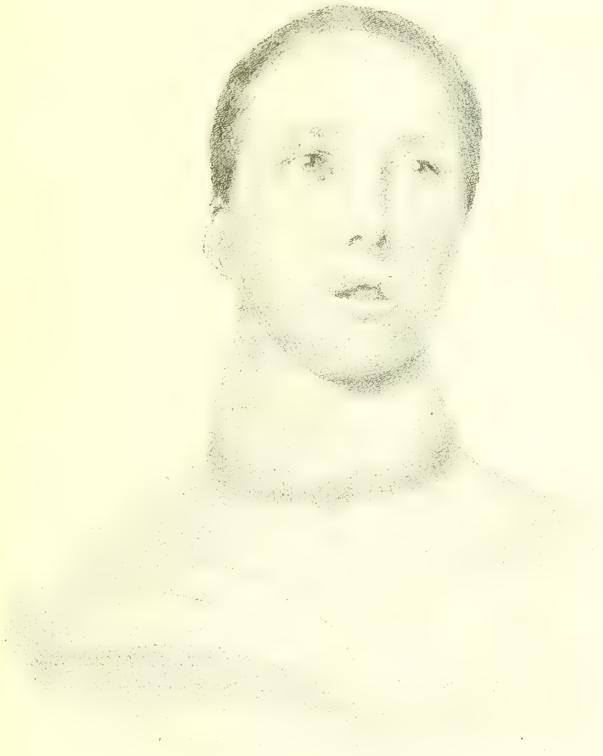

FIG. 341.—Parenchymatous enlargement of the thyroid.

Other symptoms are due to pressure. Large, slowly-growing tumours, iat project in front and become pedunculated, do not offend in this way. mall ones, on the other hand, that lie in the isthmus or extend around the achea between it and the œsophagus, and dense nodules that are sometimes arcely apparent on the surface, are often much more serious, especially their growth is rapid. The trachea may be flattened, bent, or displaced one side of the neck. The cartilages may be absorbed, the recurrent ryngeal nerve paralysed, the movement of the œsophagus interfered with, id the great vessels and nerves stretched or flattened. Sometimes goîtrous yroids suddenly enlarge; they are exceedingly vascular, and excitement violent exertion may lead to such intense congestion as to cause instant eath.

Acute goître is very rare in England, although it is described as occurring in an epidemic form among troops in France. There is a certain amount of evidence connecting it with the rheumatic diathesis, but the cause is as obscure as that of the common variety. The swelling is rapid and painful, the neck cannot be bent, the skin is tense and white; usually there is considerable dyspnœa with hoarseness, and sometimes a rather high degree of fever. It has been suggested, on the analogy of mumps, that it is really a form of specific inflammation, but it has not been shown to be contagious.

The hyperæmia that occurs during the menstrual period and at pregnancy is usually transient, and merely causes a feeling of fulness and tenderness in the neck. In a few cases, however, the swelling never subsides completely, and it may be followed by fibrocystic degeneration.

Pulsating bronchocele may occur as part of Graves' disease or independently. In the former case the whole gland is uniformly enlarged, all the blood-vessels are dilated, the pulsation is equally marked over the whole surface, and the solid tissues do not hypertrophy until the disease has lasted some time. In addition, the enlargement of the gland is associated with other symptoms which have been assigned (although on very inadequate evidence) to a lesion of the sympathetic. In the latter case the primary affection appears to be the development of exceedingly vascular intracystic growths, although of course the blood-supply of the whole gland is increased

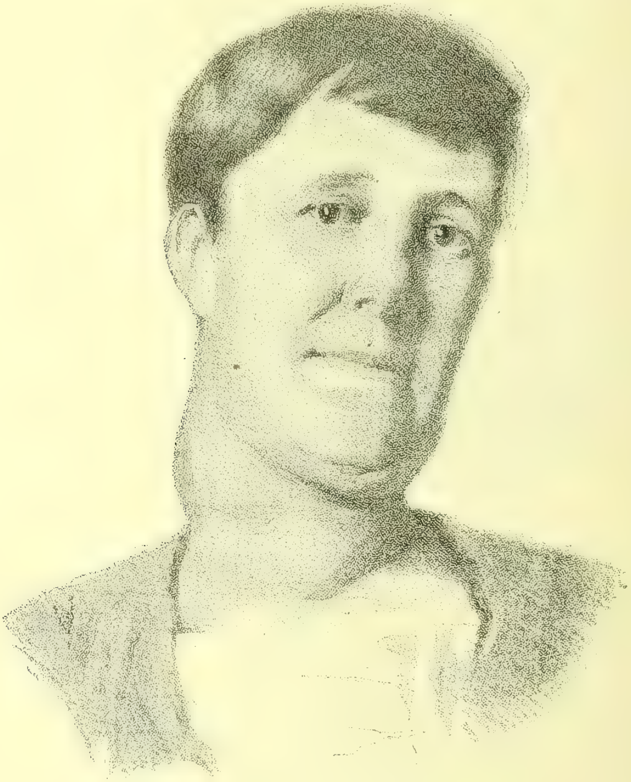

FIG. 342.—Cystic bronchocele.

as well. The surface is covered with bosses, some of which pulsate so strongly that they may be mistaken for aneurysmal dilatation of the carotid or subclavian; and the amount of stroma and solid tissue is considerably and irregularly increased. Many of the cysts are filled with broken-down blood-clot and tissue-débris; and the changes these undergo in course of time add considerably to the varied character of the morbid appearance. Disease of this kind may remain unchanged for years, sometimes growing larger—when the patient is out of health—and then again diminishing, without apparently producing any constitutional effect. In one or two cases, however, secondary deposits of a similar character have made their appearance in distant parts of the body, as if the primary growth had in some way infected the blood-stream.

Fibroid and fibrocystic goîtres may attain an immense size. Generally one element is very greatly in excess of the other, but they rarely occur entirely by themselves. The shape and density of the swelling, and the symptoms it causes by pressing upon neighbouring organs, naturally differ according to its character and direction.

Diagnosis.—All thyroid swellings move up and down with the larynx in swallowing. Accessory thyroids (which sometimes undergo a similar transformation and develop into gigantic tumours) present the greatest difficulty. They may occur in any part of the neck, naturally most often in front, but sometimes under the mucous membrane of the trachea or larynx, or below the upper border of the sternum. Bursal cysts developed in connection with the thyrohyoid space, congenital cysts and such rare tumours as tracheoceles, can hardly be mistaken.

Treatment.—A very great deal may be done for recent parenchymatous goîtres and for some forms of pulsating bronchocele. Even when fibroid or cystic degeneration has set in, the size of the swelling can be considerably reduced, but the prospect of perfect resolution is not nearly so good. Graves' disease, in which the affection of the thyroid occurs as part of a general disorder, stands on a different basis.

Nothing is of much use so long as the patient lives in a goîtrous district. Whatever may be the reason, there is no question that goître occurs endemically in certain localities; that otherwise healthy people moving into them are often affected, and with somewhat acute symptoms (possibly the epidemics among troops in France are due to this); and that if they remove in sufficient time the swelling is very likely to disappear again. The only precaution is never to drink the water of the district in any form; but it has not been proved that this will prevent the disease.

In *recent goître* strong iodine liniment or iodide of potash ointment applied to the skin of the neck often effects considerable improvement; and the iodide may be given internally with iron and other tonics. Hydrofluoric acid is said to be beneficial, but although I have tried it in a large number of cases I have failed to detect any result. It must be remembered that goîtres of all kinds are very variable in size, not merely after injury or when a person is out of health, but for entirely unknown reasons; they have been known to disappear suddenly of themselves; so that, unless the improvement is decided and permanent, it cannot be taken as evidence of the value of the drug. Biniodide of mercury ointment, as applied in England, does not appear to succeed.

If this fails, or if the thyroid is already in a state of *fibroid enlargement*, hard, irregular and dense, injections of a solution of iodine in alcohol (one part in twelve) may be tried. About half a drachm is injected into different parts of the gland once or twice a week, according to the severity of the reaction that follows. Care must be taken that the point of the needle is really in the gland (this may be shown by making the patient swallow), not in the cellular tissue, and particularly to avoid the veins. The seat of the injection becomes slightly red and swollen, and the patient may complain of vague sensations of pain in the neck, but anything more serious very seldom follows. Suppuration may occur, but it is very rare, and embolism has been known to happen, so that the procedure is not entirely devoid of risk.

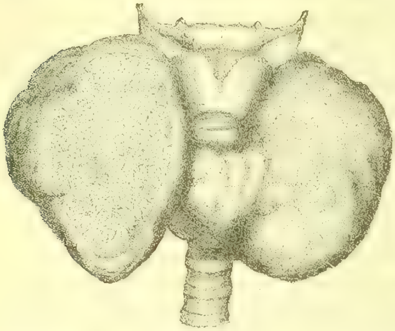
FIG. 343.—Colloid degeneration of thyroid.

Cystic goitre may be treated by aspiration, drainage, enucleation, or injection. Of these the first is of little avail, except as a temporary expedient in an urgent case, or as a preliminary to other measures. The fluid must be drawn off very slowly, or hæmorrhage may occur from the delicate vessels in the walls of the sac and fill it even more tensely than it was before.

Drainage and enucleation are more successful. A linear incision is made through the superficial structures, and the capsule of the gland freely exposed. If there is a large single cyst it can usually be enucleated by careful dissection, clamping and dividing between two ligatures every vessel; solid adenomata may be treated in the same way. If this is impracticable, the cavity can be laid open and the contents cleared out, but the operator must be prepared for smart hæmorrhage. Plugging with iodoform gauze may be necessary if it does not stop at once. It does not appear to be necessary to fasten the edge of the cyst to the skin or the cervical fascia; according to Clutton, if the superficial structures are not disturbed or displaced, there is very little risk of inflammatory infiltration. If there is a number of small cysts closely packed together, it is better to excise the part, so long as it is not too large, ligaturing the vessels one by one as they appear and taking especial care of the recurrent laryngeal nerve.

Injection with perchloride of iron (25 per cent. solution) is very strongly advocated by Morell Mackenzie with the view of exciting limited suppuration without hæmorrhage. The cyst is tapped, partially or completely emptied, according to its size, and injected with a drachm or two of the solution, avoiding manipulation as far as possible. The syringe is then withdrawn, the cannula plugged and left *in situ* for about three days. At the end of that time the contents are allowed to escape, and if they are thin and serous, or if there is much blood—if, in other words, suppuration does not appear probable—a second injection is made. Poultices are applied to encourage this, and the cannula is retained as a drainage-tube, until there is no longer any fear of the opening becoming valvular. This plan is not devoid of risk by any means; suppuration may be acute with high fever, and, although it is usually successful, the inflammation may cause serious misgivings for a time.

Electrolysis has been used with considerable success in vascular goître, even when there were definite exophthalmic symptoms. Duncan recommends a current of from 40 to 80 milli ampères, and relies chiefly upon the destructive action of the negative pole, moving it about freely from side to side as soon as it has produced a decided effect. Injections certainly should not be used in these cases.

Under certain circumstances operative treatment becomes imperative. The trachea may be compressed or distorted, causing marked tracheal stridor and dyspnœa on the least exertion. The recurrent laryngeal nerve may be irritated or stretched; if this occurs on both sides the condition at once becomes very critical. A firm growth may extend downwards between the trachea and the sternum, or embrace the trachea, or grow backwards against it so as to compress it; or there may have been already an attack of suffocative dyspnœa due to sudden enlargement of the gland.

The choice lies between tracheotomy, division of the isthmus, enucleation of the growth, and ligature of the arteries supplying the gland.

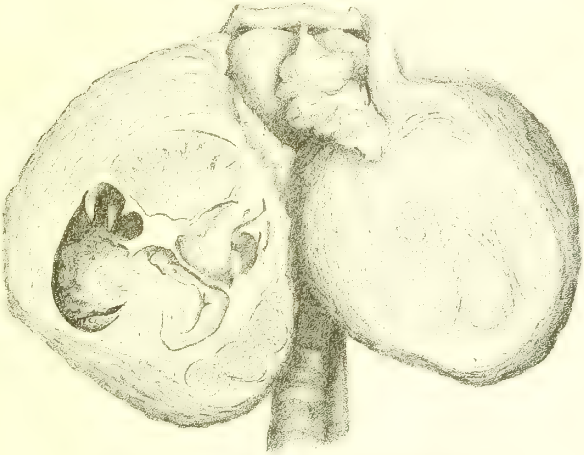

Fig. 344.—Cystic degeneration of thyroid.

Tracheotomy, of course, is only palliative, it may be necessary on the pur of the moment, a special tube, or, if this is not at hand, a gum-elastic atheter, being passed down the trachea through the constricted part. The lifficulty of such an operation can hardly be exaggerated; low tracheotomy s, of course, out of the question—even the upper part of the trachea may e concealed or pushed to one side, or flattened, so that it presents a sharp dge or so covered with dilated vessels and portions of the growth as to e almost inaccessible. Bose's method (transverse division of the cervical ascia, and pulling all the structures forwards and downwards from off the ront of the trachea) may be the only one practicable.

Division of the isthmus, on the other hand, is exceedingly successful, nd, in a large proportion of cases, has been followed by the unexpected liminution in bulk of the rest of the gland. To some extent this may be lue to the recession of the lateral lobes, but certainly this will not account or the whole. The incision is vertical, in the middle line; the skin and uperficial fascia are divided; then the layer connecting the sternohyoid nd sternothyroid muscles (which are usually much flattened out); the veins that lie on the front carefully detached, and the isthmus separated from the trachea by means of the finger and a director. A double ligature is then passed round the isthmus and the intervening tissue excised; or the median part may simply be divided, and allowed to retract. This operation has been performed in exophthalmic goître, for the relief of the dyspnœa; the lateral lobes were considerably reduced in size before the patient's death, some time after, from cerebral symptoms.

No definite directions can be laid down for enucleation: it may be practised either in the case of cysts or solid adenomatous growths, and sometimes considerable portions may be removed in this way (the part left undergoes hypertrophy, so that the operation is practically free from the risk of myxœdema, unless the amount taken away is very large); but the greatest care is necessary if the growth lies anywhere near the recurrent laryngeal nerves. On several occasions one has been divided, and in many others their function has been seriously impaired by the inflammation that followed.

Ligatare of the thyroid arteries has been tried; but, at the best, it can only be palliative, and the result has not been sufficiently good to justify the risk.

Malignant Disease of the Thyroid Gland

Sarcoma and carcinoma are both known to occur, but they are not common. The former may be either round-celled or spindle-celled, and may be recognised by the rapidity of its growth, and (when the cervical fascia has yielded before it) by its soft, almost fluid, consistence. The latter is stated to be either encephaloid or scirrhus. It does not occur until late adult life, and usually as a complication in goître, the thyroid suddenly beginning to enlarge and becoming painful. The diagnosis cannot be made until the lymphatic glands or the neighbouring tissues are involved; and removal is out of the question. It is probable that the secondary pulsating growths, similar in structure to a cystic proliferating thyroid, and occurring in distant parts of the body, are really carcinomatous.

CHAPTER XVI

INJURIES AND DISEASES OF THE PHARYNX AND ŒSOPHAGUS

MALFORMATIONS

CONGENITAL occlusion of the pharynx is due to the invagination that forms the mouth failing to open into the anterior end of the primitive intestine. In congenital stricture the defect is the same, but less marked.

Diverticula may originate in the same way. Some of these are acquired (pharyngoceles): a part of the wall is weakened by inflammation or injury to such an extent that the mucous membrane bulges out through the opening; the larger ones, however, and especially those that occur in the region of the inferior constrictor, are congenital in origin. When small they are not noticed; as they increase in size they form a pear-shaped swelling by the side of the neck, pressing upon the great vessels, displacing the larynx, and often causing dyspnœa and violent fits of spasmodic coughing from pressure upon the superior laryngeal nerve. The nature of the sac is easily recognised from the variations in its size at different times, and from the way in which its contents (air and sodden food) are returned into the mouth when it is subjected to external pressure, or squeezed by the muscles around it. As it enlarges it displaces the œsophagus, becoming more vertical and drawing nearer the middle line, until the natural passage is thrust entirely out of its axis. In one of these cases Wheeler laid open the tumour from the outside, excised it, and successfully secured the margins of the opening with catgut sutures.

Congenital dilatation of the œsophagus has also been described as affecting its whole length, but this is still more rare. A minor degree of the same disorder sometimes results from fatty degeneration of the muscular wall. As a rule, hypertrophy and narrowing occur above a stricture.

INJURIES OF THE ŒSOPHAGUS

The œsophagus may be wounded from the outside in cases of cut-throat, or from inside by corrosive fluids or hard and sharp-pointed foreign bodies. In rare instances rupture has taken place during vomiting, but probably only when the walls have been weakened beforehand by inflammation or fatty degeneration.

Swallowing corrosive fluids is nearly always done with suicidal intent, the liquid (usually a mineral acid or a very strong alkali) being thrown quite to the back of the pharynx, so that the lips, mouth, and tongue are often not touched. The immediate effect is profound collapse with intense burning pain, followed by vomiting of mucus, blood, and sloughing shreds of epithelium, mixed with the contents of the stomach. If the result is not immediately fatal from perforation or collapse, the severity of the symptoms gradually subsides; there is less blood and more mucus and pus in the fluid that is brought up; the pain becomes less severe; the swelling and thickening around the œsophagus diminish, and the febrile symptoms abate. Swallowing, however, causes very great pain, and if more than the epithelial surface has been destroyed, it rapidly becomes more and more difficult, until at length a traumatic stricture is established. The wall of the œsophagus contracts spasmodically on the irritant before it is vomited back, and thus it may happen that the whole of the tube, from the cricoid almost down to the cardiac orifice, is more or less eaten away. In cases of long standing the walls become enormously thickened from inflammatory deposit and fused with the structures around. The interior is rough and irregular, marked by sloughs and cicatrices in all directions, and here and there the cavity may be completely obliterated.

Foreign Bodies in the Pharynx and Œsophagus

False teeth, pieces of unmasticated food, coins, fish-bones, pins, and the like, are not uncommonly impacted in the œsophagus—generally where it is narrowest, at the level of the cricoid cartilage—but sometimes immediately behind the arch of the aorta or the left bronchus.

The symptoms depend chiefly upon the size and shape. If it is large and smooth, instant death may occur from its pressing upon the aperture of the larynx, or from spasm of the glottis; if pointed and irregular, there may be dysphagia (and the feeling of soreness persists long after the foreign body has been removed) or complete obstruction. Tenderness in the side of the neck, soreness behind the sternum, dyspnœa, and a constant discharge of saliva and mucus, are often present as well. Later, if the case is left to itself, inflammation sets in. Sometimes this leads to spontaneous expulsion, as the foreign body becomes loosened; more frequently it makes matters worse by extending into the tissues around. Abscesses may form under the deep cervical fascia and spread into the pleura or pericardium. The walls of the carotid, and even of the aorta itself, may give way. The foreign body may ulcerate through into the trachea, and be coughed up, or it may be driven into the pericardium and even into the substance of the heart.

When the foreign body is a large one there is seldom any difficulty in the diagnosis. The finger can explore the whole of the upper part of the pharynx, from the level of the soft palate down to the back of the arytenoid cartilages, and in children even lower; and the mucous membrane may be thoroughly inspected by means of a laryngoscope mirror; but when it is situated below this, and is of small size—a fish-bone, for example—its presence is often only a matter of inference. In many cases the sensation persists long after the offending substance has been dislodged.

Treatment.—A foreign body must always, if possible, be extracted through the mouth; if it cannot be done it may be pushed on into the stomach, removed through a side opening, or left to itself according to its nature and situation. Sometimes it is ejected during the retching and vomiting that accompany exploration of the fauces, but emetics should never be given for the purpose. The œsophagus has before now been ruptured by violent vomiting. Long-handled, curved forceps, such as are used for extracting similar bodies from the larynx, are the most useful, especially if it happens to be something small and rough. Pins and fish-bones may be caught by an expanding or umbrella probang (fig. 345), but care must be taken not to drive them farther in: they may easily be forced into the carotid or pericardium. If smooth and firm and low down, the obstructing body can sometimes be pushed onwards, especially as, after a few hours, it becomes coated over with mucus; and in the case of meat it has been proposed to soften the surface by means of dilute acids. Irregular structures, such as false teeth, are most easily laid hold of by what is known as a coin-catcher (fig. 346), a blunt, flat hook attached to a probang by a thin strip of steel, so that it can glide past an obstacle and then catch against it as it is withdrawn; and considerable force may be used. If this fails, and if the foreign body is impacted in an accessible part of the œsophagus, it must be removed by operation.

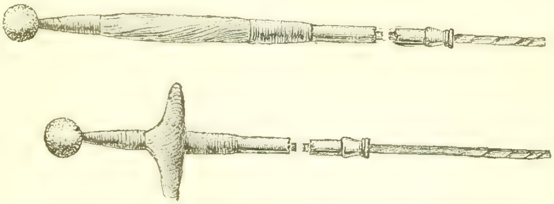

Fig. 345.—Horsehair probang, expanded and unexpanded.

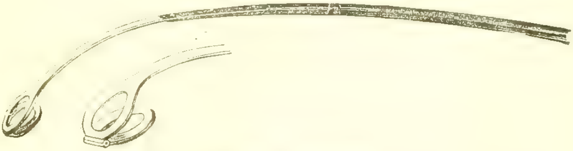

Fig. 346.—Coin-catcher.

Unless there is some special reason—such, for example, as the projection of the foreign body distinctly to be felt—œsophagotomy is always performed on the left side. The head is turned in the opposite direction and an incision three inches long is made at the inner margin of the sternomastoid. The superficial structures are divided, the deep fascia slit up on a director, and the muscle pulled well towards the outer side so as to expose the sheath of the great vessels. The dissection is then carried carefully between this and the trachea, avoiding the thyroid arteries and veins, the thyroid gland, and the inferior laryngeal nerve, until the œsophagus and the lower part of the pharynx are exposed. If the omohyoid muscle gets in the way it may be divided, and any veins that cannot be drawn to one side must be secured either by ligature or by pressure-forceps, so as not to obscure the deeper parts. Generally a sufficient surface can be brought into view by pulling the trachea one way and the great vessels and he sternomastoid the other; but sometimes part of the sternohyoid or ternothyroid requires division. If the foreign body can be felt from the outside, a longitudinal incision may be made over it and the finger introduced o as to ascertain its position more accurately. If this cannot be done, a ound is passed through the mouth and made to project in the wound. Afterwards the opening may be enlarged to a sufficient extent, and the foreign ody withdrawn with appropriate forceps. If the impaction is recent and he wound in the œsophagus not bruised, the edges may be sewn together with catgut, the sutures being inserted only in the muscular wall, leaving he mucous membrane untouched. Under other circumstances it is better o leave the whole open, with a large drainage-tube in the superficial wound. For the first few days the patient should be fed with nutrient enemata nly; afterwards an œsophageal tube may be used until the wound is sound. he thirst can be relieved, as Southam suggests, by allowing the patient to rink a boracic acid mixture (gr. x ad ℥j). Most of it flows out through the wound (if it is not sutured), and helps to keep it clean. A fistulous opening often persists for a time, but in most cases it closes without requiring anything further.

When the foreign body is low down the question is more difficult. Southam performed œsophagotomy successfully in a case in which a plate of false teeth was impacted three inches below the upper border of the sternum. In other cases the stomach has been opened and the foreign body dragged onwards or pushed back as seemed best at the time.

Gastrotomy may be required if it has passed the œsophagus and is lodged in the stomach. Sometimes the foreign body can be felt through the wall of the abdomen ; if this is impossible its presence can usually be ascertained with a suitable probang. In most cases, however, if it has once reached the stomach it is able to pass on through the pyloric valve without further trouble, although it may lodge again just above the external sphincter. Purgatives should never be given : vegetable and farinaceous diet is the best, owing to its bulky character.

Diseases of the Œsophagus

Inflammation of the mucous membrane may arise from injury (as already mentioned) or from specific causes, such as tubercle, syphilis, thrush, or diphtheria ; but, with the exception of the first of these, the symptoms are vague, consisting merely of pain in swallowing, and rarely attract attention unless the ulceration is so extensive as to lead to the formation of a cicatricial stricture.

Paralysis of the muscular coat of the pharynx or œsophagus is occasionally met with after diphtheria, and may in rare instances be due to alcoholic or lead-poisoning. Dysphagia is always present, but it differs from that which occurs in stricture, in that solids are swallowed more easily than fluids. Sometimes the food collects and is ejected after a time by coughing or vomiting.

Hysterical paralysis is much more common, the patient being convinced either that there is a foreign body in the œsophagus, or that there is a stricture (usually after having seen a case) and being unable to will the act of deglutition. It is chiefly met with in young women who present other hysterical symptoms, but it may occur in men. The suddenness and incongruous nature of the symptoms, the history and a few days' careful watching, are sufficient to prevent a mistake. The greatest difficulty is in connection with foreign bodies : a fish-bone perhaps has been actually swallowed and scratched the mucous surface ; and the sensation arising from this, and intensified whenever anything passes down, is a sufficient stimulus to keep up the suggestion of dysphagia in the patient's brain. It rarely happens, however, that there is any collection of food above the obstruction : either the patient keeps it in the mouth without attempting to swallow it, or, if it does pass over the larynx, it is immediately ejected again, often with an unnecessary display of energy.

Closely akin to this, and occurring under the same conditions, is a form of muscular spasm which affects the pharynx rather than the œsophagus. It varies from merely a slight stammering of deglutition, such as might arise from simple nervousness, to violent ejection of the contents of the pharynx through the mouth and nose. In neither of these conditions, however, whether paralysis or spasm is the prominent feature, is there marked emaciation or craving for food: the patient is usually fairly well nourished, though always complaining (differing in this respect altogether from those who persistently refuse to take any food), and not unfrequently it is found on making inquiry that it has already lasted many years off and on, long enough to negative absolutely organic contraction.

Many of these cases are cured at once by faradisation or the passage of a bougie, but unless the morbid state of the nervous system is in some way relieved, or the exciting cause of the hysteria removed, they nearly always relapse.

TUMOURS OF THE ŒSOPHAGUS

With very few exceptions, the only form of new growth that occurs in the œsophagus is squamous epithelioma. It is chiefly met with in men, very rarely under forty years of age, and forms an annular and rapidly contracting stricture. The surface ulcerates away, but, as in the intestine, the infiltration into the submucous, and later into the muscular coats, increases so fast and contracts so rapidly that the calibre very quickly becomes narrowed. Later it involves the fibrous tissue and the other structures around (the trachea for example), spreading into them by direct extension, and, if it does not prove fatal from starvation or pneumonia, forms secondary deposits in the glands and elsewhere.

The seat of election is behind the cricoid cartilage or where the left bronchus forms a ridge in the mucous membrane—the places, in other words, in which the calibre is smallest and the walls most rigid. No part, however, is exempt.

The chief, and for some time the only symptom of which the patient complains, is a rapidly increasing difficulty in swallowing, first for solids and then for liquids. Emaciation speedily follows; but fortunately the sense of hunger, especially in the later stages, is seldom very distressing. Vomiting may occur, the saliva, with a certain amount of mucus, particles of food, and sometimes a little blood, collecting on the face of the stricture. Pain is rarely severe, although, particularly when the tissues around the œsophagus are infiltrated, attempts at swallowing or passing a bougie cause great discomfort. No external tumour can be felt, with rare exceptions; and often there is no distinct glandular enlargement until comparatively late.

STRICTURE OF THE ŒSOPHAGUS

Organic stricture may be congenital or acquired. The former is exceedingly rare; the latter, which is very common, may be simple or malignant.

Simple stricture arises nearly always from the swallowing of corrosive fluids. The mucous membrane sloughs and cicatricial contraction follows. Sometimes almost the whole length is obliterated in this way, but the effect is always greatest at the commencement. In very rare instances it may arise from some form of specific inflammation, such as tubercle or syphilis.

Malignant stricture is always the result of squamous epithelioma, and is usually annular, the muscular coat above being considerably hypertrophied.

Symptoms and diagnosis.—Pain and difficulty in swallowing are the prominent symptoms. The former is exceedingly severe at the beginning in cases of traumatic stricture (in great measure owing to the inflammation around the œsophagus), and gradually becomes less as the cicatricial tissue becomes firmer. The latter is usually the only thing of which a patient complains when it is due to epithelioma. It may come on comparatively suddenly, an unobservant person not noticing any difficulty until the narrow channel is blocked by the impaction of a larger or harder fragment than usual, or, more frequently, it is gradual from the first, solids causing difficulty before there is the least obstruction to the passage of liquids. In a few instances deglutition is rendered almost impossible by fits of spasmodic coughing.

The diagnosis can only be made certain by the passage of a bougie; but, as dysphagia occurs in other affections in which a proceeding of this kind is not unattended with danger, an attempt must always be made to exclude them first.

(*a*) *Muscular spasm* or *paralysis* may simulate true stricture. There may even be a history of some foreign body having been swallowed; but it is never the kind that causes traumatic stricture. Nor is there really any likelihood of mistaking spasmodic contraction for malignant disease, for while the latter rarely occurs except in men, and never under the age of forty, the former is almost confined to young women, and is always marked by the peculiar incongruity of its symptoms. In diphtheritic paralysis, which is very rare, the food usually passes slowly down for some time before it stops, and solids are swallowed more easily than liquids.

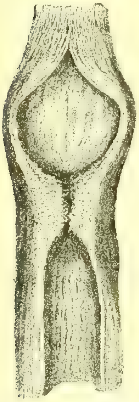
FIG. 347.—Malignant stricture of œsophagus, laid open.

(*b*) *Compression of the œsophagus.*—Dysphagia arising from this is exceedingly common, and although the cause is usually sufficiently prominent, this is not always the case. Aneurysms of the aorta; tumours of all kinds growing from the vertebræ, lymphatic glands, cellular tissue, or other structures near the œsophagus; enlarged or accessory thyroids; gummata (especially retropharyngeal); abscesses, connected with the vertebræ or not; and other conditions may give rise to it. Aneurysms have been ruptured before now by the passage of a bougie, and that, too, without an excessive amount of force having been used.

(*c*) In a few cases *dysphagia* has been traced to the presence of a pharyngocele dragging the orifice of the œsophagus out of its true axis.

The **diagnosis** of simple from malignant stricture rarely gives rise t difficulty. Practically, unless there is a very clear history of a gumma or o tubercular disease, a stricture that develops after the age of forty withou injury is malignant.

If the presence of an external tumour pressing upon the œsophagus i negatived, a bougie must be passed, not only to verify the existence of stricture but to ascertain its locality, and, perhaps, its diameter. Th patient should be seated on a straight-backed chair and the head supporte by an assistant. It should rather be made to poke forwards than upward in order to straighten out the cervical spine; if it is thrown back the bougi strikes against the bodies of the vertebræ. A medium-sized gum-elastic on (equal to No. 14 or 16 catheter on the English scale) should be chosen t begin with, warmed by dipping in hot water, and well lubricated wit glycerine. The point should be bent down a little. The operator the standing in front of the patient, runs the forefinger of the left hand over th ongue, and guides the bougie, which is held in the right, over the base to the ack of the throat. If protected like this, it cannot pass up into the nasoharynx or enter the larynx. Nearly always it causes a certain amount of pasm as soon as it touches the mucous membrane, and when it comes near he cricoid it is not unfrequently gripped tightly and then forcibly ejected by etching, or suddenly pulled out by the patient. To some extent this can e prevented by a cocaine spray, or by brushing the surface of the mucous nembrane over with a 2 per cent. solution, but nearly always, except in the ase of very ignorant men, it can be overcome by patience. No force may be sed under any circumstances ; I have more than once known pneumonia levelop suddenly after a bougie had been passed.

If the end is definitely arrested but not gripped, it must be withdrawn nd a smaller one selected ; in some cases only a catgut will pass. Measured n a bougie, the cricoid cartilage is approximately seven inches from the teeth, he left bronchus eleven, and the opening in the diaphragm fifteen.

Other methods of examining the œsophagus are of very little value. uscultation (the stethoscope being placed by the side of the spine, while the atient drinks some water) may be tried, but it rarely gives any indication hat can be interpreted. The condition of the lungs, especially the amount f bronchial irritation caused by the passage of a bougie, and the state of the ervical glands, whether enlarged or not, are very important factors in the rognosis.

The **treatment** of stricture of the œsophagus depends upon the cause, hether it is traumatic or cancerous. In the former case the walls are sually very much thickened (although it may be a long time before the loughing in the interior ceases), the patient is often young, and there is no anger but that of starvation ; in the latter, if the patient lives sufficiently ong, ulceration always gains the upper hand and causes perforation, and ven if starvation and pneumonia are successfully prevented, the result ust inevitably prove fatal within a few months from the malignant achexia.

(1) *Traumatic stricture.*—In any case in which the interior of the sophagus has been seriously injured, contraction must be prevented by the se of bougies. Treatment should commence as soon as the sloughs have eparated and cicatrisation is beginning, the greatest care, of course, being sed. Special instruments with rubber tips, one or two inches in length, as to ensure thorough flexibility, and about the size of a No. 14 or 16 theter, are the most useful. At first they must be passed every day, then, the tendency to contract is not very marked, at gradually increasing tervals ; but, as it may be necessary to make use of them for the rest of fe, the patient should learn as soon as possible how to pass them for him-lf. The food must, of course, be suitably prepared throughout.

In old cases, in which the stricture has been allowed to contract, the fficulty is very much greater. Gradual dilatation is the most successful ethod, using slightly conical instruments. It may be necessary to begin th catgut, if the constriction is very narrow, leaving it *in situ* for twenty-ur hours, or making use of it as a guide on which a fine rubber tube can slid down ; the patient can always swallow liquids by the side of it. In-nal œsophagotomy (division of the stricture from within) is a very risky eration, and as the stricture must be a permeable one to allow of its being ne, can very seldom be advised. In exceptional instances an artificial opening has been made in the neck below the stricture (œsophagostomy), and the stomach has been opened and the stricture dilated through the cardiac orifice. Practically, if dilatation fails gastrostomy must be performed. The results, compared with those of the same operation for malignant disease, show a far higher percentage of success, but it is not probable that all the unsuccessful cases have been published.

(2) *Malignant stricture.*—Excision of the growth has been practised with success, an artificial opening into the œsophagus being left at the root of the neck; but cases in which such a proceeding is possible are very seldom met with. As a rule, all that can be done is to make an artificial opening below the stricture, either in the œsophagus or stomach, or to maintain the patency of the canal by means of tubes or bougies.

(*a*) *Œsophagostomy.*—This can only be performed when it is certain that the growth is limited to the very commencement of the œsophagus—a condition practically impossible to prove. The incision is the same as for œsophagotomy, but lower down, and as the tube is collapsed and empty, covered with important vessels and in close relation with the pleura and thoracic duct, it is infinitely more dangerous.

(*b*) *Gastrostomy.*—The results of gastrostomy for malignant disease of the œsophagus are exceedingly bad. It is true that they have improved to a certain extent in recent years, and that in all probability if the operation were performed earlier in the course of the complaint, before the patient was exhausted by starvation and the growth of the malignant disease, they would improve much more. But it must be remembered that gastrostomy is only a palliative, not a radical operation; it does not pretend to cure the patient, but only to relieve him, and that, therefore, if the same result can be obtained in other ways, it is not justifiable to run the risk. Symonds has divided the course of the disease into two periods: before and after the signs of bronchial irritation have set in. Of these the symptoms that occur in the former can be relieved as well by tubage (in all ordinary cases) as by gastrostomy; for those of the latter neither is of any real avail. If ulceration has once opened up a communication between the œsophagus and the bronchi, or trachea, food can be prevented from passing down into the lungs, but nothing can prevent the entry of mucus, saliva, blood, and particles of the growth detached by ulceration, and these will inevitably cause a speedily fatal broncho-pneumonia. In a few exceptional cases gastrostomy may still be necessary, and then it should be performed as early as possible, while the patient still retains his strength; but it rests with those who advocate it to show that the immediate dangers attending tubage are more serious than those of gastrostomy, or that tubage tends to make the progress of the disease more rapid by irritating the growth.

(*c*) *Tubage.*—Symonds' tubes are from four to six inches in length, and are made of gum-elastic upon a silk web, the outside and inside being as smooth as possible. The upper end is funnel-shaped so as to rest upon the face of the stricture, and slightly flattened on one side that it may not press unduly against the back of the cricoid, and the margin is perforated in two places for the attachment of a silk thread. The other end is hollow, with a lateral opening. The tube can be introduced upon a bougie, but it is more easily managed with a proper whalebone guide set in a suitable handle. The exact site of the stricture is ascertained first and marked upon the guide; the greatest gentleness must be used, and as soon as the point enters the narrowed part the tube is slowly pushed onwards until the resistance of the funnel is felt; the guide is then withdrawn, and the silk thread attached to the tube tied round the ear or fastened with strapping.

A tube of this kind can be left for two or three months without being changed, the patient swallowing liquid food through it. As a rule, however, it is necessary to remove the first after three or four days, as the stricture always dilates to some extent, and sometimes this must be repeated. Even if it should slip through, it will pass *per anum* or remain lodged in the stomach without inconvenience.

Compared with gastrostomy this method possesses very great advantages. There is little risk to life; the presence of the tube does not appear to increase the rapidity of the ulceration, although, in one or two instances, it is said to have caused circumœsophageal suppuration; the discomfort is not greater, if so great, and a sufficient amount of food can be taken quite as easily. In either case the end is the same; as soon as bronchial irritability becomes a prominent feature, as soon as the ulceration extends into the air-passages, débris, mucus, and foreign matter of all kinds will make their way into the lungs and set up broncho-pneumonia (all the more rapidly because of the malignant disease), whether a short tube is worn or gastrostomy has been performed.

When this final stage is reached the only course left is the introduction of a long tube made of thin rubber, so as to exclude, as far as possible, all fluid from the œsophagus. Krishaber's are too hard, and very soon cause ulceration at the back of the larynx from the constant friction. Soft red rubber ones may, however, be used for a considerable time. In ordinary cases, in which the malignant growth is situated high up, life may be prolonged in this way for a further period; but when the disease is opposite the left bronchus, the thin partition very soon ulcerates through, pneumonia is sure to follow, and even gangrene of the lung may occur.

CHAPTER XVII

INJURIES AND DISEASES OF THE CHEST

INJURIES OF THE CHEST

Fractures and dislocations of the ribs or sternum, contusions of the wall of the thorax, and wounds involving the nerves, muscles, or vessels, may occur with or without injury to the subjacent viscera. In some cases it can be seen at once whether they have escaped or not, in others it is a matter of the greatest difficulty; but, if there is the least doubt, the case should be treated as if the graver injury were proved, and no attempt must ever be made, by probing or otherwise, to determine one way or the other. The finger may be used to explore for foreign bodies, or to ascertain the depth and extent of a penetrated wound, not to find out whether it penetrates or not.

Injuries of the Wall of the Thorax

Contusions are very common, and are rarely attended by serious consequences. The shock, however, may be severe (it is said to have proved fatal by itself, without visible injury of any kind), and the extravasation, when it takes place in the deep planes of loose cellular tissue beneath the muscles, is sometimes very extensive, and is likely to be followed by suppuration. In many cases the muscles are badly bruised; occasionally they are torn as well, especially the pectoralis major, which may be pulled in two by a sudden catch at something as the body is falling. When this occurs the signs are very definite; a great gap appears at once, involving particularly the sternal part of the muscle; there is very extensive hæmorrhage, and when this subsides the torn ends retract as far as they can, and waste away. Nothing can be done for it when the muscles and fascia are torn completely through, but if the injury is not quite so severe a fibrous cicatrix forms and ties the ends down to the wall of the thorax, so as to make a new attachment.

The deeper structures do not always escape when the external injury is apparently slight; the pleura may be bruised and become inflamed; there may be a contusion of the lung with hæmorrhage into the substance, causing pneumonia and even traumatic gangrene; or, without the pulmonary pleura being torn, the air-vesicles may be ruptured, and the air forced into the cellular tissue of the lung until it appears at the root of the neck (*interstitial emphysema*); and in young patients particularly, when the ribs are still elastic and the wall of the chest can yield without breaking, the lung and pleura may be lacerated, so as to cause pneumothorax or hæmothorax, without there being external injury of any kind: even the pericardium and the heart may be crushed and torn.

Fracture of the Ribs

The ribs may be broken either by direct or by indirect violence. In the former case the position of the fracture depends upon the force, and the fragments are driven inwards, for the moment at any rate. In the latter, if the chest is compressed from before backwards, they generally give way at the widest part of their curve—in the axillary line—and the ends are forced outwards, so that there is less risk of the lung being wounded ; but this is very far from invariable. In rare cases the fracture results from muscular action.

The first rib can only be broken by direct force, and then it is scarcely possible unless the clavicle gives way as well. The last two escape, from their small size and free mobility. Those that suffer the most frequently are the long ones, attached at both their ends. One only may give way, or several may be broken on both sides, or they may be broken in more places than one; but this, owing to their elasticity, is unusual. In children, fracture is not common, and sometimes, when it does occur, it is incomplete. As age advances, and the thorax becomes more rigid, the liability becomes more marked. In old people they break very readily, and this also occurs in general paralysis of the insane and in some other forms of lunacy, owing, in all probability, to a change in the chemical composition of the tissue. Erosion by an aneurysm, or a secondary deposit of carcinoma, may occasion so-called spontaneous fracture.

Symptoms.—Except in the case of the first rib, or in very stout people, there is rarely any difficulty. Sometimes a sudden snap is heard at the moment of fracture ; the pain is immediate and severe, coming on with sharp stabs at every breath, so that respiration is shallow and carried on mainly by the abdominal muscles. Coughing and local pressure make it tenfold worse. Close inspection sometimes shows that one side of the thorax moves less than the other. Displacement in simple fracture without comminution is rare, but occasionally one side is depressed, the splintered end catching against the irregularities on the other half and holding it down. Crepitus is usually present. Sometimes when it cannot be felt it can be heard with a stethoscope. Laying the hand on the side of the thorax while the patient draws a deep breath is sufficient in most cases ; if this does not succeed, pressure may be made with the two hands alternately, one on either side of he supposed fracture. Sometimes the loss of spring can be detected in this way. Fracture is very probable when pressure upon a distant portion of a rib always causes pain at the same spot.

Union generally takes place readily ; sometimes the amount of callus hrown out is excessive, so that several ribs become joined together by bridges of bone (fig. 348) ; occasionally it is fibrous only, or a bony ring is hrown out round the ends, holding them together, without there being any rue union at all.

The costal cartilages may be fractured in the same way as the ribs ; or hey may be torn away from the bone or dislocated from the sternum or rom each other. Union generally takes place by bony callus thrown out ound the ends ; if they overlap, the angle is filled up by it, especially on he pleural surface ; but fibrous tissue, and occasionally bone and new-formed artilage, have been found between them.

Dislocation of the ribs from the vertebræ sometimes occurs in severe njuries of the spine, but hardly admits of diagnosis.

Complications.—These may be immediate, due to injury of some adjacent structure, or remote, the consequences of inflammation. The former include wounds of the skin, with or without the entrance of foreign bodies; rupture of muscles (the intercostals always, sometimes the pectorals and the serratus magnus too); laceration of the pleura; wound of the lung (with emphysema, hæmoptysis, pneumothorax, or hæmothorax); wound of the heart or pericardium; wound of the diaphragm, with the liver, spleen, or intestine; or rupture of the internal mammary or intercostal arteries, or of some of the great vessels in the thorax. The latter, so long as the fracture is simple, are of rare occurrence, though I have known suppuration even under these conditions; when the injury is more severe, pleurisy, pneumonia, and inflammation of other structures are not uncommon.

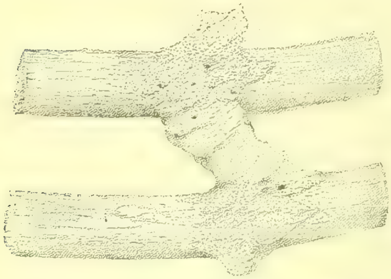
FIG. 348.—Fracture of ribs welded together by callus.

Fractures of the ribs may be serious, especially in old people, from shock, or from bronchitis and broncho-pneumonia; as a rule, unless several are broken or some grave complication is present, there is no cause for anxiety. When the fracture is on one side only, great relief is given by restricting the movement of the thorax. The patient must empty his chest as far as possible; and then strips of plaster must be placed round it from the spine to the sternum, commencing below, and arranging them so that each covers at least half the preceding one. Over this may be placed a flannel roller, which is prevented from slipping down by means of a brace over the shoulders. When, however, several are broken, especially if they are on both sides, compression is not unlikely to increase the patient's discomfort. In this case a sheet of gutta-percha may be carefully moulded to the sides, or the patient may simply be placed in bed, propped up with a bed-rest, so that the breathing shall be interfered with as little as possible, and kept perfectly quiet. In severe cases this plan should always be adopted. Nothing can be done to remedy displacement. The air in the room should be kept warm and moist, so as not to cause any irritation; the diet should be light and the bowels kept open; stimulants are rarely required. If there is not much expectoration, but merely constant irritation and tickling, small doses of compound tincture of camphor or of chlorodyne may be given; but when the respiration is difficult and embarrassed from the amount of expectoration, opium is better withheld, and replaced by iodide of potash, carbonate of ammonia, and stimulating expectorants.

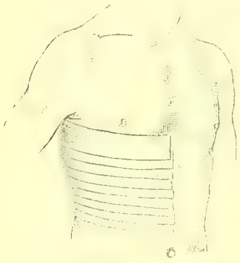
FIG. 349.—Strapping in fracture of ribs.

If the dyspnœa is very severe, and cyanosis setting in; if it is evident, from the frothy blood-stained sputa and the presence of moist râles, &c., over the chest, that the pulmonary congestion is becoming severe, and if the pulse is hard and rapid, there should be no hesitation in having recourse to venesection, though this is more often required when the lungs themselves are injured.

Injuries of the Sternum

The sternum may be broken by direct violence, as in gunshot injuries; by indirect, as in extreme flexion of the spine, when the chin is driven down on to the manubrium, and the vertebræ dislocated; or by muscular action combined with over-extension of the back, as in parturition, when the two ends seem literally to be pulled asunder. In the first case the fracture may be transverse, longitudinal, or comminuted, according to the kind and direction of the force; in the two latter the line of separation is usually transverse, and lies near the junction of the manubrium with the gladiolus, and there may be either dislocation or fracture. If there is a well-developed joint between the two portions, with a soft central space, almost arthrodial, the former will occur; if the two are firmly united, the separation may take place above or below. The displacement is nearly always the same, the lower fragment carried in front of the upper.

The **diagnosis** as a rule is easy, owing to the marked character of the deformity. Reduction can sometimes be effected at once; more often it is a matter of very great difficulty, and sometimes quite impossible; and it very rarely happens, when the fragments have been restored to their normal relation, that they can be prevented from slipping back again. The prognosis, so far as the fracture is concerned, is good; but the shock is often extreme, and laceration of the pleura or pericardium, rupture of the internal mammary vessels, compression of the heart, and other grave complications, are not unfrequently present.

Non-penetrating Wounds

Non-penetrating wounds are rarely serious. If the muscles are divided, or if a large artery, such as the subscapular, is torn across, there may be free hæmorrhage for a time, but it is easily checked. Sometimes, however, in punctured wounds a large hæmatoma forms in the loose cellular tissue under the scapula and proves dangerous from inflammation, and the same thing may occur with lacerated and gunshot wounds, which often, owing to the resistance of the ribs and the yielding character of the tissues that cover them, extend much farther than is at first sight apparent.

The greatest care must be taken not to convert them by needless examination into penetrating ones. In most cases the question can be settled without touching the wound, its extent and the character of the weapon making it certain at once; but sometimes the diagnosis is difficult, and I have known a considerable degree of emphysema caused by injuries which certainly did not penetrate, where, for instance, the spike of some iron railings ran obliquely upwards beneath a boy's scapula. Foreign bodies must be removed, even if they are fixed in the ribs, and the bleeding stopped as soon as possible. If the muscles are divided, catgut sutures may be passed through the fascia investing them, in the hope of drawing them together, and the greatest attention must be paid to position, so that there may be no strain upon them; but usually they unite either to the skin or to the tissue beneath. Drainage is very important, especially where the deep planes of cellular tissue are opened up; and the chest should either be strapped or fixed as far as possible, or, owing to the want of rest and the constant movement of the ribs in respiration, union is very likely to be delayed.

INJURIES OF THE THORACIC VISCERA

Rupture of the Pleura

Rupture of the costal pleura by itself probably occurs in every case of fractured rib or severe contusion of the thorax, but owing to the skin being unbroken the injury is repaired at once, with only a transient or local pleurisy at the most; and though such complications as hæmothorax from rupture of an intercostal or internal mammary artery and pneumocele may occur, they are very rare. When there is an external wound the pleura alone may be injured, without the lung, if the weapon is blunt and enters the thorax slowly, so that it pushes the lung in front of it, or if the wound is in the tenth or eleventh interspace; for though the pleura usually extends as low as the last rib, the lung, unless it is emphysematous, only reaches the tenth. In this case, however, the diaphragm and the subjacent viscera are very likely to suffer.

Other complications depend upon the size and extent of the wound. If it is merely a puncture or a small incision the diagnosis is often never made; but if it is extensive the lung may protrude without injury through the opening (*hernia*); it may collapse and fall back, leaving the pleura full of air (*pneumothorax*); the cavity, as already mentioned, may be partly filled with blood, and the air may either pass in and out freely through the wound (*traumatopnœa*) or it may be forced into the cellular tissue under the skin, and spread over a considerable area (*emphysema*). This, however, is seldom extensive unless the lung is wounded as well. Finally, at a later period, pleurisy may set in and even run on to empyema.

Injuries of the Lung

These may occur, as already mentioned, from mere contusion or compression of the thorax; they are very common as a result of fractures of the ribs; and occasionally they are met with as a result of external wounds, penetrating from the outside. The wound may be superficial or deep, it may be punctured, incised, or lacerated, with or without the entrance of foreign bodies, and it may be so trivial that it is never diagnosed, or it may cause instant death. The simpler forms of wound heal at once by the first intention without any inflammation and with very great rapidity. Severe contusion, owing to the extravasation into the air-vesicles, is attended with a greater amount of consolidation and with rusty blood-stained sputa for several days, but the dulness rarely extends and there is little or no fever. If, however, the extravasation is very great, or there is an external wound, so that the blood decomposes, intense septic pneumonia and even gangrene may follow; but there is always such an amount of pleural effusion, and the lung, as a rule, in these cases is so collapsed and compressed against the back of the thorax, that the physical signs are very obscure.

Symptoms.—The two characteristic signs of wound of the lung are hæmorrhage and the escape of air.

The former may take place into the bronchi, so that the sputa consists either of pure blood or of a frothy, bright red mixture, which in a day or two becomes rusty and black; or it may collect in the cavity of the pleura (hæmothorax) and gradually soak into the surrounding tissues, so that the skin on the loins becomes dark and ecchymosed; or it may escape externally, mixed with air, or almost pure. So with the air. In very rare instances, where the vesicles alone are torn without the pleura being injured, it may escape into the cellular tissue of the lung and make its way along the outside of the bronchi into the mediastinum, and so gain the root of the neck; or it may collect in the pleural cavity, entering at each expiration, until it distends the thorax to its utmost and compresses the lung against the back; or, what is far more common, without entering the pleura at all, it finds its way across into the cellular tissue and gives rise to surgical emphysema; or, finally, if there is a large open wound, it is sucked in and out of the chest at each respiration, mixed more or less with blood.

Besides these, other symptoms are usually present. The shock of such an injury is severe and sometimes fatal, even when the amount of bleeding is not great; anxiety and distress are always marked; sometimes the dyspnœa is slight, but usually it is severe, and if the lung becomes rapidly collapsed it may be extreme; there is a constant sense of irritation and tickling in the throat, with an intense desire to cough, but the deep fixed pain in the chest prevents it, and if the hæmorrhage is severe the patient may sink rapidly into a state of collapse.

Wounds of the Heart

In comparison with the lungs, the heart, as might be expected, is very rarely injured. The pericardium, however, may be torn, the valves ruptured, and even the substance of the heart rent across in violent compression of the thorax; the sternum or the costal cartilages may be broken and driven down into it, or it may be wounded from the outside by stabs or gunshot injuries. In a very few cases the pericardium only has been injured, or the surface of the heart. Much more frequently one of the cavities (the right ventricle especially) is laid open. Besides this, the pericardium and even the heart may be wounded by foreign bodies, fish-bones, &c., driven through the wall of the œsophagus.

Death may take place immediately from shock or from blood collecting in the pericardial space and stopping the action of the heart. If the patient escapes these, secondary consequences—continued hæmorrhage, and, later, inflammation—are almost sure to prove fatal. Recovery is stated to have taken place in about fifteen per cent., but, probably from the interest attaching to such cases, this estimate is too high, even for civil practice. Foreign bodies, however—even bullets—have been found *post mortem* embedded in the substance of the heart, or projecting into one of its cavities; and fibrous cicatrices, with a thickened and adherent pericardium, have been demonstrated in many cases. Wounds of the auricle appear to be more fatal than those of the ventricle.

Signs.—In the absence of an external wound, the only signs are extreme shock with very great distress, and rapid, sometimes almost instantaneous failure of the circulation. Dyspnœa is very common, possibly pointing to pericardial hæmorrhage and compression of the heart. Sometimes it is immediate, at others it does not come on for some minutes. Pain is very variable: it may be acute, or it may be masked completely by the shock and distress. The heart-sounds are usually inaudible, but in a few cases splashing and other abnormal ones have been heard. When there is an external wound the blood may pour out in a stream that is almost immediately fatal, or, especially in stabs where the opening is small or valvular, and when the wound in the heart is in the direction of the fibres, there may be very little.

The only treatment that is likely to be of any avail is absolute rest, cold, and opium; venesection has been recommended to relieve the heart, but it can very rarely be necessary. The external wound may be closed in the hope of arresting hæmorrhage; but it must not be forgotten that accumulation of blood in the pericardium is one of the common causes of death. On one occasion I attempted to close the wound with sutures.

The great vessels may be injured in the same way; and, as a rule, accidents of this kind are even more rapidly fatal. Punctures of the aorta inside the pericardium, through the second intercostal space, and wounds of the coronary artery, end by allowing the blood to accumulate around the heart and compress it. Injuries to the other viscera in the thorax are more rare. A very few cases are recorded in which the œsophagus has been wounded from the outside. It is not uncommon to find foreign bodies driven through its wall from the inside, into the pleura, pericardium, and aorta. The thoracic duct has been divided, leading to a profuse flow of milk-like fluid during digestion; and it has also been ruptured without external wound, so that the pleural cavity became distended with chyle.

Rupture of the diaphragm is sometimes met with, on the left side, from extreme compression; and of course it may be injured anywhere by stabs, gunshot wounds, or fragments of ribs driven in. In most cases the neighbouring viscera are fatally injured, but sometimes they escape, and the stomach or intestines may be squeezed up through the opening into the thorax, leading to great distress, with vomiting and dyspnœa. When the rent is small, they may be strangulated at once. If this does not happen, traumatic diaphragmatic hernia persists for the rest of life, as the wound, if it is of any size, is never repaired. It may be distinguished from the congenital form by its situation and by the absence of a peritoneal covering.

Primary Complications—Hæmorrhage

This may come from arteries in the wall of the thorax (the intercostals or the internal mammary), from the lung, or from the heart and great vessels, and the blood may escape either internally (into the pleura, pericardium, or mediastinum) or externally. To diagnose one from the other, it has been recommended that a folded card should be introduced deep into the upper angle of the wound with its concavity outwards; blood from a wounded intercostal will escape along the channel of the card, that from the thorax will pour out behind it.

(*a*) *External hæmorrhage.*—The intercostal arteries for the most part of their course are so protected under the margins of the ribs that they are rarely injured; at the back, however, they cross the interspaces obliquely. When they are divided in gunshot injuries or in resecting portions of ribs, the amount of hæmorrhage is seldom large, but a few cases are on record in which it appears to have been very serious. If the wound leads down to a rib, the bleeding point should be well exposed, and an incision made on to the lower margin of the bone to ensure the artery being completely divided; then the soft structures may be pushed to either side with the finger-nail, so that the vessel may have a chance of retracting, and firm pressure may be kept up with the finger for a few minutes. If this does not succeed, the periosteum may be dissected back, carrying the artery with it, or forcipressure may be used, or as a last resource the wound may be plugged either with a dilatable india-rubber ball or by laying over it a piece of antiseptic gauze, filling the centre of this with pledgets of cotton, and forcing it into the wound, so that when it is slightly drawn out it expands in all directions, and compresses the vessel against the rib. Passing a ligature around the rib, close to its inner surface, and resecting a portion of the bone, have been recommended when the hæmorrhage could not be checked in any other way.

Wound of the internal mammary, owing to the size of the vessel and the freedom of its anastomoses, is much more serious, and in many cases has proved fatal either at once or later from secondary hæmorrhage, even when no complications were present. The blood may escape externally, or into the mediastinum or pleura ; and the only effectual method for arresting the flow is to cut down upon it and tie both ends, removing, if necessary, a portion of the costal cartilages, or of the margin of the sternum. In the first three spaces this is fairly easy, but lower down it becomes more difficult, until in the fifth and sixth it is almost impossible.

When external bleeding comes from a wound in the lung, the diagnosis is generally only too easy ; usually it means that a large, and therefore deep, vessel is torn across ; air rushes in and out at the same time, and cough, dyspnœa, hæmoptysis, hæmothorax, and great distress are present as well. The external wound must be carefully but quickly cleansed ; any accessible foreign body removed ; and then the opening must be closed, the patient laid upon his injured side, and the most absolute rest enforced, in the hope that, as the blood collects and the heart beats more feebly, a coagulum may form and block the vessel. Tight constriction of the thorax is not well borne, but the injured side should be immobilised as far as possible. Stimulants should never be given ; inhalation of turpentine, or subcutaneous injections of morphia and ergotine, may be tried ; and apparent benefit has been derived from giving ten minims of tincture of ergot every hour, but the power of these remedies is not very great. Venesection was extensively practised in the Crimea for the purpose of procuring collapse, but since then has been almost abandoned. If the patient survives, the amount of food and drink for the next few days should be reduced to the barest possible. If the pleura is filled with blood, so that the lung is collapsed against the posterior wall of the chest, and if the dyspnœa is very extreme, the wound may be opened, and the blood (or if it has coagulated, the serum) allowed to escape ; but this can very rarely be required, and it must be remembered that it may always lead to fresh hæmorrhage.

(*b*) *Internal hæmorrhage. Hæmothorax.*—Pleural extravasation nearly always comes from the lung ; exceptionally it may proceed from the arteries in the wall, or from the heart or great vessels. The blood pours down at once to the lowest part of the cavity (depending, therefore, upon the position of the patient, whether he is sitting up or lying down) and soon coagulates. If the quantity is small and no air is admitted, it is absorbed again, and except for slight dulness and diminution of the breath-sounds at the base, there is no way of diagnosing it. If, on the other hand, the amount is large, and if air gains access to it (pneumo-hæmothorax), inflammation, with a great increase in the pleural effusion, and suppuration, are almost sure to follow. When the air is filtered through the lung, instead of entering directly through an opening in the thorax, this danger is not so great.

When the extravasation is large, there are all the symptoms of severe hæmorrhage, in addition to the physical signs. The face and lips are white; the skin cold and moist; the patient sits propped up, rocking himself backwards and forwards, or throwing his arms from side to side, gasping for breath, and on the verge of syncope. The pulse is small and thready, too quick to be counted; there is intense thirst, the pupils are dilated, and often there are attempts at vomiting. In such cases death may ensue at once, partly from the loss of blood, partly from the difficulty of respiration; or after a time the severity of the symptoms may diminish and the pulse gradually recover. Generally, when this is the case, ecchymosis makes its appearance in the loins after a few days, due to the blood-colour soaking through; sometimes the whole is absorbed, but more frequently the temperature begins to rise; perhaps there is a rigor, the area of dulness increases, the dyspnœa becomes more marked, and it is clear that inflammation is setting in.

The early treatment of hæmothorax is not materially different from that of wound of the lung with external hæmorrhage. The first indication is to stop the bleeding. If it can be proved that this arises from one of the intercostal arteries or from the internal mammary, exploration would be justifiable, but hæmothorax under such conditions must be very rare. There is nothing at first but rest, cold, opium, ergot, and restricted diet; gallic and sulphuric acids, and acetate of lead also enjoy a certain amount of reputation. Where the dyspnœa is extreme, and it is evident that it is due to collapse of the lung, relief may be given by inserting a fine cannula and allowing some of the serum to escape slowly, so as not to relieve the pressure on the wounded vessel too suddenly; but though this is not unfrequently necessary in pneumo-hæmothorax, it is very rarely required where there is only blood. Later, after three or four days, if the effusion shows any signs of increasing, or if there is any rise of temperature, this method of treatment is of very great service. It is very improbable after such a lapse of time that the increasing dulness is due to hæmorrhage; much more likely it is the result of pleural effusion, consequent upon the tension; and allowing some of the fluid to escape under its own pressure not only diminishes the amount (if it is going to suppurate) but assists the absorption of the rest by allowing the lymphatics to act again. This may be repeated on several occasions as the blood-coagula slowly break down, but no force may be used to draw the fluid out.

Accumulation of blood in the pericardium or in the mediastinum is very much more rare; the former is nearly always associated with wound of the heart or the first portion of the aorta; the latter with injury to the internal mammary artery or the great vessels at the root of the neck.

Hæmoptysis.—If a large vessel is injured this may be profuse, the blood pouring out from the mouth and nose in gushes until the patient sinks into a state of syncope. When profuse, it always points to injury of the lung; but the blood must be intimately mixed with the air, and bright red in colour, for it to be conclusive. If it is not, it may have come from the larynx, or even have trickled down from the nose or some other part, and been coughed up again. After a day or two it becomes rusty and dark, more like the sputum of croupous pneumonia.

Pneumothorax

Air may enter the pleural cavity either from without through an external wound, or from within through a rupture of a lung or the bursting of a cavity in its substance. In the former it enters during inspiration: in the latter during expiration, the air being driven out of the lung into the pleural cavity so long as the tension in it is less than that of the trachea; but neither can occur unless the wound is of some size or very irregular. The adhesive force between the two layers of the pleura is such that, in spite of the elasticity of the lung, it requires some pressure to separate them. In incised wounds of the chest the pulmonary pleura has been seen in contact with the costal, gliding on it as the lung expanded or shrank, but not separating from it; and in punctures from ribs, where emphysema of the subcutaneous cellular tissue is exceedingly common, pneumothorax is exceedingly rare.

If there is an external wound the diagnosis of pneumothorax is evident at once; when due to penetration or rupture of the lung, the physical signs are the same as when it is produced by the rupture of a tubercular cavity. The chest on the injured side becomes over-distended, the intercostal spaces are bulged out, and the viscera displaced; the ribs remain motionless in respiration; there is tympanitic resonance over the whole of the front, but often, owing to the effusion of fluid, slight dulness at the base behind; and breath-sounds are entirely wanting unless they are transmitted along the wall from the other lung. On shaking the patient, metallic tinkling and splashing may be heard, if there is any fluid present as well as air; and when a coin is placed upon the skin and struck with another, a clear bell-like sound is transmitted to the ear placed on the opposite side.

The treatment depends upon the amount of distress. Dyspnœa is always severe; but if it is not extreme, the patient should merely be kept perfectly quiet in bed, propped up in the easiest position, until the air is absorbed. The rent in the lung becomes very small when it is collapsed; repair takes place readily; the air soon disappears, and the lung quietly expands again. If, however, the difficulty of breathing becomes very great, especially if signs of congestion of the opposite lung—frothy blood-stained sputa and moist râles—make their appearance, a fine cannula should be introduced, and some of the air allowed to escape under its own tension; and this may be repeated as often as required. Venesection is seldom necessary. Later, as already mentioned in hæmothorax, if there is fluid mixed with air at the bottom of the cavity, as much of it as possible should be allowed to flow away in the same manner.

Emphysema

In wounds of the thorax air may find its way into the subcutaneous cellular tissue, and be driven farther and farther by the movement of the muscles, until it spreads all over the body, and renders the features perfectly unrecognisable, the scalp, the palms of the hands, and the soles of the feet alone being exempt. The looser the skin the more distended it becomes, but it remains soft and white, and when it is touched there is a fine crackling sensation as the bubbles of air are driven through the meshes of the areolar tissue. The same thing apparently is met with in decomposition from incipient putrefaction, but the other conditions are very different.

Surgical emphysema may be caused in various ways, but there is only one, when it is due to the ribs being broken and driven into the substance of the lung, in which it attains any importance.

1. It may occur in the case of a simple valvular wound of the skin.
2. From wound of the pleura only, when air is sucked in during inspira-

tion, and, owing to the obliquity of the opening, is unable to escape freely in expiration.

3. From rupture of the air-vesicles, without the pleura being torn. This, which is distinguished as interstitial emphysema, is more likely to occur from injury to the apex of the lung, whether from external contusion or from violent compression of the thorax. The air gradually finds its way into the mediastinum, and from there to the root of the neck.

4. From fracture of the ribs. Owing to the cohesion of the pleural surfaces, the air, without ever really entering the pleural cavity, is forced across it by each act of expiration into the cellular tissue, and is driven farther and farther until it may extend over the whole body. Pneumothorax very rarely occurs; the wound in the pulmonary pleura, as it glides backwards and forwards, corresponds twice in every breath to that in the costal, and the air passes directly from one to the other.

Emphysema can be recognised at once by the peculiar crackling sensation when the skin is pressed. Generally it is limited to the region of the wound; those instances in which it is extensive are of comparatively rare occurrence. As a rule, it requires no treatment: the air soon becomes absorbed; when it is causing great inconvenience small punctures may be made in the skin, or pressure may be used to try and restrain it; but this is not very successful, and, fortunately, is seldom required. It is said to have proved fatal from interference with the respiration.

Hernia of the Lung

Pneumocele, hernia, or prolapse of the lung is an occasional but rare complication of injuries of the thorax. It may be either immediate or secondary. In the former case there is generally a wound of some extent in the parietes, and the lung is forced out through it by a violent effort at expiration when the glottis is closed. It may be injured itself or it may not, but as soon as it is squeezed out through the rent it expands so that it cannot return, and rapidly becomes congested. In extreme cases it may be strangulated. If seen shortly after the accident an attempt may be made to return the protrusion, and, if necessary, the wound may be slightly enlarged for the purpose; but if some time has elapsed, and the tissue is very much congested, it is better left where it is to slough off and granulate over; or its separation may be assisted by ligature or actual cautery. A very few instances are recorded in which, owing to extensive injury of the thorax, an immediate prolapse of the lung has occurred without an external wound.

The consecutive variety may not make its appearance until some considerable time after the receipt of the injury, and if there has been a wound it must have healed first. It forms a soft circumscribed tumour projecting through the wall of the thorax under the skin, swelling out on expiration and shrinking on inspiration. On coughing there is a distinct impulse; if it is pressed upon it collapses readily with a feeling of soft crepitation, and the margins of the opening can be plainly felt. It is resonant on percussion, and the respiratory murmur is loud and coarse in comparison. In some cases it is the result of extensive rupture of the intercostal muscles; in others, where its formation is very gradual, it is probably due to chronic inflammation weakening the wall of the thorax at one spot, and allowing the lung slowly to force its way through. The only treatment required is a belt or truss, according to the size and situation of the protrusion, to restrain it and protect it from injury.

Foreign Bodies

Bullets and other weapons impacted in the wall of the thorax present no special peculiarity; they should be removed as soon as convenient, but it must be remembered that doing so may give the first proof that the injury involves the cavity of the chest as well as its wall. If the foreign substance is lodged in the pleura, it may either (as in the case of fragments of clothing, wadding, splinters, &c.) remain in the neighbourhood of the external wound, or if it is heavy, like a bullet, sink down to the bottom, and rest upon the surface of the diaphragm, near the spine. Occasionally under these circumstances it becomes encysted; much more frequently acute inflammation, running on to suppuration, sets in, and the foreign substance is discharged through the opening made to evacuate the pus.

The same thing occurs when it is lodged in the lung. Instances are recorded in which bullets, fragments of bone, or of metal, and other similar substances, have remained quiet for years, becoming surrounded by fibrous tissue and encysted, or at length have caused a certain amount of chronic suppuration, leading to their discharge either externally or through one of the bronchi. As a rule, however, the termination is not so successful: either acute septic pneumonia, running on to gangrene, occurs, or chronic inflammation, ending in phthisis, follows.

The question of extraction depends entirely on whether the foreign body is accessible or not. No attempt should be made to remove it from the pleura, unless there is a distinct indication as to locality; and in the case of the lung the greatest caution must be exercised; fatal hæmorrhage sometimes follows the extraction of a weapon, but if there is a reasonable suspicion that anything is left the external wound should not be closed.

Secondary Complications

The secondary troubles that occur after injuries of the chest are for the most part the result of inflammation, which may involve the walls of the thorax, the pleura, pericardium, lungs or heart.

Extra-mural suppuration.—Abscesses may form as the result of contusions, either in the superficial tissue or deeper under the muscles, when they often spread for long distances before they point. In all cases they should be opened at once; the deeper ones can often be reached from the axilla, along the margins of the muscles, but if this cannot be done the opening must be made wherever the drainage is likely to succeed best. If there is any doubt as to the existence of pus, or the direction of important vessels, Hilton's method should be employed.

Necrosis of the ribs or sternum is not unfrequently assigned to injury. Sometimes it may be due to this alone, but in most of the cases in which this complication is present there is a distinct history of tubercle or syphilis.

Abscesses sometimes form between the pleura and the ribs, or in the mediastinum. The former are generally associated with necrosis and soon point externally, though they have been known to burst into the pleura. The latter may attain a very large size and cause compression of the vessels and severe constitutional disturbance before their nature can be determined. Usually they point just to the left of the sternum, and if pulsation is communicated to them from the heart they may easily be taken for aneurysm; in other cases they work their way out through the bone, or pass upwards into the neck, or downwards along the internal mammary artery; or extend into the pleura or pericardium. No time should be lost in opening them as soon as the diagnosis is made.

Pleurisy and empyema.—In fracture of the ribs and in most cases of severe contusion of the thorax, a certain amount of effusion is thrown out by the costal pleura, leading to thickening of the membrane and sometimes to the formation of adhesions between the two surfaces. If, however, there is a large extravasation of blood, or if air or other foreign substance finds its way in, the inflammation is more severe; and if the irritation is kept up, or if it is of a very intense character, it ends in suppuration (empyema or pyothorax).

When this occurs the suppuration may be very acute, ushered in by rigors and high fever; or it may be chronic, the effusion gradually increasing, and becoming more and more purulent, as when empyema succeeds serous pleurisy. In most cases it is general, but it may be local at first.

The physical signs are usually well marked. If there is no wound the side of the thorax is enlarged and the neighbouring viscera displaced, the breath-sounds are either altogether lost over the lower part of the chest on that side, or, if the effusion is not so great, they are replaced by weak and distant bronchial breathing. Over the same area there is absolute dulness, the level rising day by day, and varying a little with the position of the patient; and sometimes ægophony can be heard at the upper margin. When there is an open wound the pleura is filled to a great extent with air, and there is a profuse discharge of fluid, sometimes pure pus, sometimes broken-down blood-clot, according to the amount of hæmothorax that preceded the empyema and the length of time since the accident.

The pleurisy that occurs in connection with simple fracture nearly always gets well of itself; if fluid does collect, and is not absorbed, it may be withdrawn with an aspirator. If suppuration sets in, the first consideration is to ensure perfect drainage, so that the pus cannot be pent up and decompose. When there is an external wound it must be enlarged, carefully examined, and explored with the finger to ascertain if there is a foreign body which has been overlooked, or any other cause; and in most cases it is advisable to make a second opening at once. When there is no wound aspiration may be tried; but if the fluid is of such a character that it cannot be evacuated in this way (if, for example, it consists largely of blood-clot that has not yet become liquid); or if, after a certain amount of success, the cavity begins to fill again, it must be drained. If it is done at once, before the pleura has become condensed and thickened, the lung will expand again and become adherent to the wall of the thorax.

Pneumonia.—Simple wounds of the lung, as already mentioned, generally heal by the first intention, with very little consolidation or effusion. If, however, there has been much contusion or extravasation; if there is an external wound; and particularly if a portion of some foreign substance, such as clothing or wadding, has been carried in, or has entered through the larynx, decomposition may set in, and excite intense inflammation and suppuration. Sometimes even then it ends in a local abscess, the pus suddenly bursting into one of the bronchi, or working out through the wall, along the track of the original wound, or even drying up and ultimately becoming caseous or calcareous; but much more often it runs on until the greater portion of the lung or of one of the lobes is involved; and occasionally it is so acute as to end in gangrene.

The locality of the pneumonia depends upon the seat of injury. The physical signs, when they can be made out, are the same as those of the ordinary croupous form, but they are usually obscured by the presence of empyema, pneumothorax, or other complications. The sputa may be rust-coloured, even when there is no inflammation, from traumatic hæmorrhage into the air-vesicles. High fever, however, following a severe injury to the lung, renders its presence practically certain. The prognosis depends upon the amount of lung involved and upon the cause.

Very little can be done in the way of treatment: constant inhalation of moist air impregnated with some volatile antiseptic, may be tried to limit the amount of decomposition; but if the condition of the breath indicates that gangrene has set in, almost the only hope lies in incision and drainage. Too often, however, the condition of the patient is practically hopeless. For the rest, all that can be done is to maintain the strength of the patient, and, if there is extensive pleural effusion, relieve the breathing by tapping.

DISEASES OF THE CHEST WALL

Chronic abscess.—This may arise from a suppurating hæmatoma, or follow the caseation of a tubercular deposit. Very often it originates in connection with a carious rib. The symptoms are usually distinctive, but care should always be taken to prove that the sac has no communication with the thorax. The cavity should be laid open freely to allow the contents to escape, explored with the finger, washed out with perchloride solution, and drained. The tube requires removing upon the second day; after that the wound may be covered with wood-wool and left until it is sound.

Tubercle may affect the subcutaneous tissue, leaving long sinuses lined with pale, flabby granulations (in one case under my care they extended across the front of the chest from one axilla to the other), or it may commence in the subperiosteal layer of the bones. It should, in any case, be thoroughly scraped out, and the wound well powdered with iodoform. Fortunately the pleura becomes so thick that there is very little risk of an empyema following.

Gummata are of frequent occurrence upon the sternum, leaving deep circular punched-out sores, with the bone beneath bare and rough.

In addition, all forms of tumours that develop in connection with fibrous or connective tissue, bone, or cartilage, are met with upon the thorax. The treatment, of course, depends upon their character; in some cases their removal is comparatively simple; in others it may be necessary to excise the subjacent bone and expose the pleura or even the pericardium. Sarcomata can sometimes be shelled out, but great care must be taken to ascertain whether they have any deep connection.

OPERATIONS UPON THE THORAX

PARACENTESIS

Paracentesis of the pleura is performed either for exploration (to ascertain the presence or the nature of fluid), or to relieve the tension in the cavity, so that the lung may expand again, and the balance between absorption and secretion be once more restored.

For purposes of exploration a large hypodermic syringe is the most suitable instrument. Care should be taken that it is absolutely clean (it is not sufficient to draw even a strong carbolic solution through the needle; all cannulæ before using should be boiled in liquor potassæ; nothing else will ensure freedom from putrid grease in the interior), and, unless it is intended to empty the cavity, only a small amount should be withdrawn. It is very easy by means of repeated punctures to convert a simple pleurisy into an empyema. The locality selected depends upon the physical signs, but the thinnest part of the chest-wall that is available should be chosen; the skin should be pulled a little to one side, so that the opening may be valulvar; and care should be taken to pass in over the upper border of a rib.

If it is intended to withdraw the fluid an aspirator should be used, adopting the same precautions, and keeping up a uniform but slight amount of suction. The operation may be required for hæmothorax; for pleurisy, if the effusion is so large as to interfere with the action of the opposite lung or with the heart, or if, though it is not large enough for this, it fails to diminish under other methods of treatment; for hydrothorax occurring on both sides (as sometimes in Bright's disease); and for empyema.

The usual situation is in the seventh or eighth space, just in front of the angle of the scapula. An anæsthetic is not required; if the patient is very nervous the ether spray may be used. The semi-recumbent position is the most convenient; the patient cannot lie upon the sound side on account of his respiration, but a finger must be kept upon the pulse, as sometimes syncope occurs if a large quantity of fluid is withdrawn, or if it comes away rapidly, probably from the viscera being unable to accommodate themselves at once to the altered conditions. A small incision should always be made through the skin with a scalpel; the walls of the thorax, even when it is full of fluid, are apt to yield a little; the trocar, however sharp it may be, does not penetrate readily; and if it does not enter smartly it may push the thickened pleura in front of it, and fail to reach the cavity. At the same time it must be guarded with the thumb, so that it may not be driven across the pleura when the resistance ceases.

The quantity of fluid withdrawn must naturally be guided by the circumstances of the case, but no attempt should ever be made to empty the cavity, and if the pulse becomes weak, or any blood appears in the aspirator, or the patient begins to cough, the needle should be withdrawn at once, and the puncture sealed with collodion. It very rarely happens that any serious consequences follow, but syncope, embolism (from the pulmonary veins), and œdema of the lung (owing in all probability to the paralysis of the walls of the vessels, caused by prolonged anæmia), have been known to occur; and, owing to the feeble nutrition of the tissues and the inflammation already present, there is distinct danger of the fluid becoming purulent.

DRAINAGE

Drainage of the pleura is very rarely required except for empyema. In the traumatic variety (that which is caused by a foreign body entering the broncni, by hæmothorax or by the rupture of a cavity) it is nearly always necessary. On the other hand, when an empyema follows simple pleurisy, aspiration may be tried first, unless it is already pointing. In children, in particular, it is often successful, and although the chance is less in the case of adults, it is always worth the attempt. The cavity, of course, is not emptied, and the residue of the pus must be removed by absorption.

In addition to the physical signs pointing to fluid in the pleural cavity, the presence of pus is indicated by rigors, hectic, or œdema of the skin; but it should always be suspected, especially in the case of children, if after any of the acute specific fevers or an operation, or, indeed, any serious illness, recovery is unaccountably delayed, and the patient, instead of improving, begins to fail and go back. If, under such circumstances as these, there is any indication of fluid in the pleura, there should be no hesitation in using an exploring syringe.

The chances of an empyema getting well of itself are very remote; nearly always it continues to increase until either the skin or the lung gives way and the contents are discharged externally or into the bronchi. In rare cases the pus works its way down behind the diaphragm and bursts into the stomach or intestines, or enters the psoas and points first in the groin. The longer it is left the more collapsed the lung becomes and the thicker the pleura, until at last, in an old-standing case that has been allowed to break of itself or has not been opened until late in the course of the disease, the pleura is dense, almost cartilaginous in its hardness, and perhaps an inch in thickness, while the lung is compressed and bound down against the vertebral column in such a manner that expansion is hopeless.

Death may occur suddenly from syncope; the heart is so much displaced and its cavities so compressed, that at the best it can only work at a grave disadvantage, and the least exertion may suddenly turn the scale; from asphyxia, owing to œdema of the opposite lung, or from the pus being discharged into the bronchi in such quantity that it cannot be coughed up; or from gradual exhaustion. If the empyema bursts it may prove fatal from acute septicæmia, the contents of the cavity becoming putrid (this is less likely to occur when the opening is into the lungs than when it is external); or, after many weeks or months, from hectic and albuminoid disease. If the lung cannot expand, the chest-wall falls in (causing a lateral curvature, concave on the affected side, with compensatory curves above and below); the heart and the other lung are displaced, and the diaphragm is forced up. Sometimes, between them, the cavity is obliterated; the lymph upon the costal pleura adheres to that upon the lung, and the sac disappears as such, leaving a deformity which, especially in the case of children, diminishes to a certain extent in course of time. Much more often, if the lung is once tied down and the pleura thickened, sufficient displacement is impossible (the upper part of the thorax, where everything is more rigid, is always the last to contract) and a sinus is left, leading to what is practically an old abscess-sac. If this is small and the opening straight, the discharge may be so trifling as to cause practically no inconvenience; more frequently the prolonged drain tells at length upon the health, and albuminoid degeneration sets in.

An anæsthetic is advisable, although special care is required, and chloroform is to be preferred to ether. The position of the patient is the same as for aspiration. In children and recent cases, and in small localised empyemata, a single incision may suffice; under other conditions two should always be made, as it is impossible for such a cavity as the pleura, when the lung is contracted, to drain efficiently through one. The usual site is in the axillary line (in front of the latissimus dorsi in the seventh or eighth space) and the two may be close together. It is better, however, to have one of them higher up in the fourth or even the third, as the lower part of the pleural cavity often becomes obliterated in a few days, so that the tube is forced out. If there is an old sinus or the pus is localised, the question, of course, is entirely different; and it may even be necessary to open the cavity behind the scapula, though this should be avoided if possible, not only on account of the depth, but because of the obliquity of the intercostal arteries. The position of the intended opening should always be marked out upon the skin before the arm is abducted from the side.

A vertical incision an inch and a half in length should be made through the skin and the superficial fascia, down to the intercostal muscles, and then either the scalpel itself (with the blade turned parallel to the ribs) or a sharp-pointed steel director thrust through the wall into the fluid beyond. The opening can then be enlarged to a sufficient extent with a pair of dressing-forceps. If the intercostal artery bleeds it is usually because it is punctured, not divided.

In ordinary cases a drainage-tube, as large as the space between the ribs will admit, should be introduced at once; a second opening made if it is thought advisable; the cavity allowed to empty itself as the patient comes round from the anæsthetic, and then the side covered in with many layers of wood-wool or some other absorbent dressing. By degrees the margins of the ribs become absorbed by the pressure of the rubber, so that there is no fear of its being nipped and compressed, even if the thorax collapses. When, however, there is an old sinus to deal with and the ribs are already pressed closely together, overlapping like the slates on a roof; or when it is thought advisable, owing to the presence of a foreign body or from other causes, to explore the interior with the finger, this is not sufficient. In the former case a circle may be cut out from the bony cuirass with a trephine, removing portions of two, or, perhaps, three ribs; in the latter, a definite segment of one may be excised. The superficial incision should be sufficiently long to expose it thoroughly; the periosteum divided along the convexity of the bone and detached from it (with especial care where the lower border is concerned), and the two ends of the exposed portion severed with curved forceps or a fine saw. The deep layer of the periosteum and the pleura can then be torn through at the bottom of the wound. The broken rib undoubtedly increases the pain for the first few days, but in a very short time it becomes welded by callus to those on either side of it.

Except in the case of foreign bodies or of localised empyemata, there is no object in the introduction of the finger; and probing the cavity should be avoided, as it makes the walls bleed and tends to separate recent adhesions. Washing out the pleura with antiseptics is dangerous and unnecessary. Even when the pus is foul and putrid the absorption ceases and the temperature falls as soon as free drainage through two openings is established. Specially made rubber tubes (like tracheotomy-tubes, only with a closed end and lateral openings) may be used, or they can be fashioned as required out of drainage-tubing, by passing it through a piece of stout rubber three or four inches square, slitting one end down on three sides, and securing the branches to the face of the shield with a suture. The length of time they are necessary varies, of course, in each case. Usually, as the openings become lined by granulations, the tubes can be shortened until they are only just long enough to project through the wall; then the question is determined by the amount of discharge. It is better to leave them in until they are practically forced out from within; if they are left off too soon, the opening begins to contract immediately; drainage is checked, and the temperature begins to rise. Replacing them, even after three days, may be a matter of considerable difficulty, requiring trephining or excision. Occasionally the exposed surface of the rib necroses, but, although this may check the healing of the wound, it rarely causes any serious trouble.

THORACOPLASTY

In old cases of empyema the lung is so firmly bound down that in spite of the aid it receives from the collapse of the walls and the displacement of the viscera, it is unable to expand sufficiently to fill the cavity. Nearly always this is due to the operation having been delayed, and if the discharge is more than a very minute quantity it is almost sure to end sooner or later in albuminoid disease. Something can be done by allowing the patient to sit up as soon as he can, encouraging him to move about, and perhaps by systematic exercises and the inhalation of compressed air, but it is not probable that this can do much. Practically the only course, if it is clear the cavity cannot contract any more, is to divide the external wall so that it may yield sufficiently. This is usually known as Estlander's operation, or thoracoplasty; it involves the removal of a considerable length (often six or seven inches) of every rib (it may be seven or eight) that enters into the formation of the wall of the cavity, and naturally should never be performed unless it is absolutely certain that obliteration in any other way is impossible. Moreover, the condition of the heart, the other lung and the kidneys must be taken into careful consideration first; adherent pericardium (which is not an uncommon complication in cases of empyema), phthisis or albuminoid degeneration, if it is distinctly present already, are practically prohibitive.

The first thing is to ascertain the shape and size of the cavity as accurately as possible with the finger and a probe. Usually it runs upwards and backwards across the general direction of the ribs, so that it may be necessary to commence at the second and remove portions of five or six; the first should of course never be touched.

A single vertical incision is usually sufficient; occasionally two may be necessary, or it may answer better to raise the soft tissues in a flap. As a rule the ribs lie so close together that it is impossible to slip the finger-nail between them, and the preliminary section must be made with a saw, commencing over the cavity at its anterior margin. As soon as a portion of one or two has been excised a better idea can be formed as to what is required. According to Pearce Gould the whole of the bone that forms the outer wall of the empyemic cavity must be taken away, a free opening being first made in front and then the rest of the wall divided from within by means of cutting-forceps. The periosteum must be excised with the ribs, and the whole of the dense and thickened pleura that lines them. The hæmorrhage, not only from the intercostal vessels but from those in the thickened pleura, is always considerable and difficult to check, and the shock of such an extensive operation is very severe. Unless the sinuses close completely the result cannot be regarded as successful.

PNEUMONOTOMY

Incision of the lung may be practised, according to Godlee, in cases of gangrenous cavities, abscesses caused by the extension of suppuration from other parts into the lung, abscesses connected with foreign bodies, bronchiectatic cavities, provided they are single (multiple ones can hardly receive much relief this way), and tubercular cavities, if there is only one, and the cough is very harassing. In one or two cases a similar operation has been practised for hydatid disease, and a few instances are recorded in which tumours have been removed from the lung. The localisation of the disease and the treatment of the pleura are the chief difficulties.

No incision may be made until the existence and accessibility of the cavity have been proved by puncture, and even then the greatest care is required, for the lung, unless it is consolidated by inflammation, is so yielding that a thick-walled sac can easily be pushed to one side. As a rule, cavities should not be approached from behind, for the large vessels run for the most part along the posterior surface of the bronchi. The size of a cavity cannot be estimated from the amount of fluid that is coughed up; according to Godlee upwards of a pint may come within twenty-four hours from a space that would not hold as much as two ounces. If a cavity is found the lung-tissue should be incised and explored as far as possible with the finger, part of a rib being removed if necessary, and a large drainage-tube inserted. The shape is always very irregular, and it must be a long time before the sloughs have separated and cicatrisation can procure its obliteration.

The treatment of the pleura presents unusual difficulties. There can be no doubt that it is not advisable to incise a putrid cavity in the lung unless the pleural surfaces are adherent. If there is localised gangrene, and if it has already lasted for some time, the danger is not so great; adhesions are usually present under these conditions, and the lung is so consolidated by inflammation that it is in but slight danger of collapsing; but in acute cases and in bronchiectasis it is impossible to be certain. An attempt may be made to find out by ascertaining the mobility of the lung; if a needle is driven through an intercostal space into the pulmonary tissue it will show to a certain extent by its movement whether the lung is fixed or not, but it is very easy to place too much reliance upon this. In some instances it may be possible to suture the two surfaces together and wait for a week, or to procure adhesions by means of the cautery applied to the intercostal muscles, but often it is impossible to wait so long, and even then the adhesions are so soft and delicate that the greatest care must be taken not to break them down.

PARACENTESIS OF THE PERICARDIUM

This may be required for serous effusion, when the quantity is increasing to such an extent that the action of the heart is failing, or for a collection of pus, such as is not uncommon in the pyæmia that complicates acute necrosis. It may be performed in any interspace from the third to the eighth (the fourth or fifth is usually recommended), preference being given to that which shows the clearest indication of fluid, and a spot should be selected about one inch from the edge of the sternum, so as to avoid the internal mammary artery on the one side and the pleura on the other. The direction of the puncture must depend upon the locality; if it is on the left of the sternum, the needle should be pushed backwards and towards the right. The right ventricle of the heart has been perforated on several occasions.

A preliminary incision should be made through the skin and a fine aspirator-needle used. If the fluid is clear and serous the cavity should not be emptied, removal of part will probably give sufficient relief; if, however, it is purulent, (this is often indicated by œdema of the skin) the incision should be gradually deepened until the pericardium is exposed sufficiently to introduce a drainage-tube.

CHAPTER XVIII

INJURIES AND DISEASES OF THE ABDOMEN

Section I.—Injuries of the Abdomen

Contusions

Blows upon the abdomen may affect the walls, or the viscera, or both together. They are always accompanied by a very severe degree of shock, and it is said that a fatal result has followed without any structural lesion having been discovered at the autopsy. Certainly death may result from such apparently trivial injuries as rupture of the parietal peritoneum without hæmorrhage, or puncture of a small hydatid cyst of the liver, probably owing to reflex paralysis of the heart.

Owing to this peculiarity it is often impossible to form a conception as to the extent of the injury (the viscera may be reduced to pulp without the skin showing a sign of bruising, as in what used to be called wind-contusions, from spent round-shot), and the prognosis must be very guarded. The shock may pass off within a few minutes or a few hours, or it may prove fatal; or it may be followed, without any break or interruption, by signs of hæmorrhage or of rupture of some of the hollow viscera.

(*a*) *Contusion and subcutaneous laceration of the wall of the abdomen.*—A hæmatoma may form in the subcutaneous tissue, or in the sheath of the muscles; in some cases the extravasation is very extensive; usually it is absorbed (leaving, if the muscle has been much injured, a weak spot in the wall of the abdomen through which a hernia may take place subsequently), but occasionally suppuration sets in. Abscesses of the abdominal wall caused in this way are characterised by the enormous amount of induration that surrounds them, and not unfrequently, even when they have no communication with the viscera, by the fœtid nature of their contents.

Laceration of muscles, especially of the rectus abdominis, is not a rare occurrence. It may be caused by a sudden effort, as, for example, in parturition, or by a blow when the muscle is rigidly contracted. In tetanus it is not uncommon, and it is said to be of frequent occurrence after typhoid fever, owing to the degeneration of the contractile substance. The signs are characteristic, but, unhappily, if the rupture is complete, nothing can be done to secure union of the ends, and an abdominal support must be worn afterwards. Laceration of the diaphragm can only be recognised, if the patient lives, by the subsequent occurrence of traumatic phrenic hernia.

The parietal peritoneum sometimes gives way by itself, owing to its want of elasticity, but this is not so common as in the case of the visceral layer, probably because of the presence of the subperitoneal fatty tissue. It may be followed by peritonitis.

(*b*) *Rupture of the viscera.*—A very slight degree of force is enough sometimes; an enlarged spleen, for example, or a distended bladder with atrophied walls, tears at once; and the latter at least will give way under the mere pressure of the muscles. Most instances, however, are due to extreme degrees of violence, the worst being what are known as buffer-accidents. The liver suffers the most frequently, on account of its size and position; sometimes the gall-bladder is torn as well. The stomach may give way (especially if it is distended), usually near the pylorus. The small intestine may be torn across (generally at the end of the duodenum, for here the most movable part is joined to the most fixed); the spleen may be ruptured; the kidney, its pelvis, or the ureter lacerated; and the mesentery, with its blood-vessels, rent in any direction. The pancreas, owing to its position, usually escapes, unless, as sometimes happens, the contents are completely crushed.

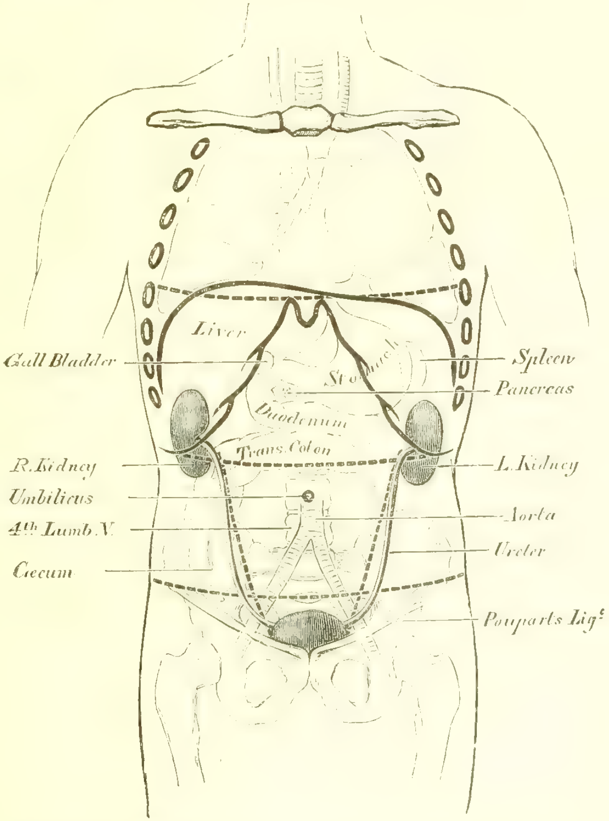

FIG. 350.—Diagram showing the position of the abdominal viscera.

The diagnosis of many of these injuries is impossible until secondary consequences have made their appearance. The patient simply lies utterly prostrate, and it is not possible to tell whether his condition is due to shock alone or to shock combined with hæmorrhage, or rupture of the viscera. The bladder may be excluded by passing a soft catheter; if it is empty at the time of the accident it is almost certain to have escaped (unless the pelvis is fractured too); if it was full, and has given way, nothing but a little blood-stained fluid follows when the catheter is passed. Hæmorrhage into the peritoneal cavity may be diagnosed by the increasing intensity of the collapse, the yawning and jactitation of the patient, and by the dulness in the flanks, the level of which continues to rise, and varies with the position; but this gives no information as to whether it is simple rupture of some mesenteric vessel, or a hopeless laceration of the liver. In rupture of the stomach there may be blood-stained vomiting; but, again, this may arise from simple bruising of the mucous membrane, or, particularly when the rent is extensive, it may not occur at all. The rapid accumulation of gas in the peritoneal cavity, causing obliteration of the liver dulness, points in the same direction. If the intestine is lacerated vomiting may occur, but the passage of blood *per anum* is more decisive. It has been proposed in cases of this kind to inflate the rectum and large intestine with hydrogen or some other unirritating gas, and undoubtedly in the case of bullet-wounds, where there is an external aperture, and the gas that escapes can be collected and identified, this proceeding is of some benefit. In other cases it can only be considered an indication if, after it is injected, resonance makes its appearance in some locality into which the intestines do not usually penetrate, as, for example, between the liver and the anterior abdominal wall.

Treatment.—In the vast majority of these accidents active measures are out of the question. The patient must be kept perfectly quiet in bed, well under the influence of opium, and with a large ice-bag over the injured part, so arranged that it does not rest its weight too much upon it. Stimulants should be avoided if possible; sometimes, when the heart is distinctly failing, they must be given, but if there is any hæmorrhage, they are only likely to precipitate the end. Only a little ice (in small fragments, and not too often) may be allowed by the mouth; any food that is considered advisable in the first forty-eight hours should be given in the form of suppositories or small enemata.

In exceptional instances it may be possible to form a more accurate diagnosis. If, for example, there is clearly some fracture of the ribs over the liver, and the hæmorrhage is serious, or if blood-stained vomiting and rapid distension of the peritoneal cavity with gas are followed within a few hours by peritonitis, indicating rupture of the stomach or intestine; or if the bladder contains but a small quantity of blood-stained urine, in spite of the fact that none has been passed, it is undoubtedly justifiable to open the abdomen, try to find the seat of injury, deal with it as it requires, and wash out the cavity thoroughly with hot water. The spleen and kidney have been removed for hæmorrhage; rents in the liver have been sewn up; the bladder has been sutured many times successfully, and life has been preserved even after fæcal matter has been extravasated into the peritoneal cavity. Unfortunately the proportion of cases in which such a proceeding can be recommended is a very small one; in by far the majority, opium is the only resource.

WOUNDS

Wounds of the abdomen are divided into those that penetrate the peritoneal cavity, and those that do not, and the former again into those that are accompanied by injury to the viscera and those which only implicate the wall.

1. *Non-penetrating wounds* may be incised, punctured, or lacerated. If

there is any doubt as to the peritoneum being involved, and the wound is more than a puncture, or if the instrument with which it was inflicted is dirty, the patient should be placed under an anæsthetic and the opening carefully enlarged, each layer of tissue being divided successively upon a director until, if necessary, the subperitoneal fat is exposed. In other respects the wounds must be treated on ordinary principles, deep sutures being used to bring the various layers together after the tissues have been thoroughly cleansed, as, owing to the constant movement of the part, it is very difficult to maintain accurate apposition in any other way. If the wound is of any size ventral hernia is very likely to follow, unless an abdominal support is worn.

2. *Penetrating wounds.*—In all wounds that involve the parietal peritoneum (except needle-punctures) the injured tissues should be thoroughly examined (the skin wound being enlarged, if necessary), cleansed, and accurately brought together with the serous surfaces in contact. A continuous catgut suture should be used for the peritoneum (so as to make sure of immediate union), if from the amount of bruising or from other causes it is doubtful whether the other tissues will heal at once. On the other hand, with a clean incised wound, the sutures may be passed through everything, peritoneum, muscles, and skin, as after an operation. Opium is usually advisable, and the dressings must be abundant and elastic (a sponge wrung out of carbolic may be placed next the skin with wood-wool over it and all around it), so as to ensure the parts being kept at rest and in accurate apposition.

(*a*) When it is certain the viscera are not hurt nothing further is required. The patient must merely be kept perfectly quiet in bed, on liquid food, until the wound is sound.

(*b*) When they are injured they must be dealt with according to circumstances. They may either protrude or not; in the former case there is the additional risk of strangulation (owing to the lessened pressure upon the extruded part it always becomes intensely congested); in the latter, of some of the contents of the hollow viscera (if they are hurt) entering the peritoneal cavity. Whichever it is, there should be no hesitation in enlarging the external wound if there is not sufficient space, or making another if it is not conveniently situated.

The omentum should be thoroughly cleansed with a dilute antiseptic and returned. If it is too dirty and badly torn, or if it is very much congested, it may be treated as in an ordinary case of hernia—ligatured in successive portions with silk, cut off, and the stump, after it is certain there is no bleeding, reduced.

The hollow viscera, if the wound involves the peritoneal surface, must be made secure by means of sutures. If there is only a small puncture, the mucous coat often prolapses and plugs the opening, so that there is no escape; but it is not wise to trust to this, it is much safer to replace the everted edges and unite the serous surfaces over it with Lembert's suture. Clean incised wounds should be treated in the same way. Even contused wounds, such as are caused by bullets, may be sutured so long as the internal diameter of the intestine is not reduced to half its normal size, and sometimes it may be possible to render them more secure by making use of omental grafts, after Senn's fashion. If, however, owing to the amount of bruising or the situation of the injury, it is not possible to effect this without causing too much contraction, or if there are numerous wounds close together, it is safer to resect the injured portion, removing it altogether, or, in addition to sewing up the wounds, to establish what is known as an intestinal anastomosis—graft one piece into the side of another. Finally, if this is impracticable, or if, from the patient's condition, it is not likely that he would stand so prolonged an operation, an artificial anus must be made, the two ends being adjusted side by side, so that in case of recovery a further operation can be performed at a later period.

In those rare cases in which the extra-peritoneal portion of the bowel is involved, the external opening should be enlarged and made as direct as possible, introducing a drainage-tube, so that the contents of the bowel may escape at once. Gangrenous intestine must be treated as in an ordinary case of hernia.

If the solid viscera, such as the liver or the spleen, are wounded, the hæmorrhage is usually very severe. It may be possible sometimes to check it in the case of the former by means of deep catgut sutures, and the spleen and portions of the liver have been excised. The gall-bladder, if it is wounded, should be sutured in the same way as the intestine.

If any fæcal matter, bile, foreign substances, or even any large quantity of blood has entered the peritoneal cavity it should be thoroughly cleansed. Hot water (105° F.) and boracic lotion are the least injurious. The sides of the wound are raised, and the fluid directed into all parts of the cavity by means of glass tubes, moving the bowels gently with the hand so that the whole surface may be bathed in turn. If a syphon-irrigator is used the force of the stream is easily regulated by raising or lowering it. The excess can be removed from Douglas' pouch with a sponge, but usually in these cases a drainage-tube is advisable for twenty-four hours.

In many cases it is difficult to tell whether the viscera have been injured or not, and if they have, in how many places. Upwards of a dozen perforations may be caused by a single bullet. It is impossible to follow the track of a ball across the peritoneal cavity, although, of course, its direction may help a little, and it is equally impossible to overhaul and examine bit by bit the whole of the intestine. It is in these circumstances, according to Senn, that inflation by hydrogen gas is likely to prove of most service, the tube being introduced into the anus and the lowest puncture found first; then into this one for the next, and so on until the whole intestine is proved sound.

The after-treatment of these cases must be carried out on general principles. Shock is always very severe and must be treated by warmth, and, if the heart shows signs of failing, stimulant enemata. Opium is absolutely necessary, as it is imperative to keep the bowels confined and as quiet as possible. Nothing should be given by the mouth for at least twenty-four hours. If there is very great thirst it can be relieved by a warm water enema with much less disturbance. As a rule, there is very little urine secreted, and if the bladder is emptied at the time of the operation it can usually be left for twenty-four hours. If at the end of that time the patient cannot pass it without straining, or if there is a complaint of distension and discomfort, the catheter must be used again. Small quantities of dilute beef-tea may be given on the second day, or a little weak arrowroot. Milk is better withheld, as it is apt to pass into the small intestine in curdled masses.

Injuries of the kidneys, bladder, &c., are dealt with elsewhere.

SECTION II.—SURGICAL AFFECTIONS OF THE STOMACH

OPERATIONS ON THE STOMACH

A CONSIDERABLE variety of operations may be performed upon the stomach. It may be opened and stitched to the wall (gastrostomy), or to the adjacent intestine (gastroduodenostomy or gastrojejunostomy); it may be opened (either for the removal of foreign bodies or for operations upon its mucous surface), stitched up again, and returned into the peritoneal cavity; or it may be opened, part of its wall excised, and the wound secured by sutures.

1. *Gastrostomy.*—This may be performed for cancerous, traumatic, or syphilitic stricture of the œsophagus, when dilatation by bougies or tubage is either impracticable or inadvisable. Until within the last few years, the mortality, especially in cases of carcinoma, was appalling, the patients dying either from peritonitis or exhaustion. Of these the former can be prevented; the latter can only be avoided by operating before the patient's strength is too much reduced. It must, however, always be recollected that this operation is in no sense a curative one; it merely treats a symptom, and if this can be done equally well with less risk to life in some other way, that way should certainly be preferred.

The line of the incision is parallel to the margin of the ribs upon the left side. The opening must, as Greig Smith points out, be as high as possible, so as to avoid traction upon the stomach; but it must be at least an inch from the edge of the liver and from the ribs. This point marks the middle of the incision, which is about two inches and a half in length. The skin and superficial structures are divided, the sheath of the rectus exposed, and, as recommended by Howse, opened in a vertical direction. If this is done, and the fibres of the muscle separated from each other in the same line with the handle of the scalpel, the orifice is surrounded by muscular fibres, and the risk of prolapse of the mucous membrane and escape of the contents of the stomach diminished. The subperitoneal fat is then exposed, divided, and the peritoneal cavity opened in the usual way.

If the stomach is distended it may present at once; nearly always, however, it is empty and collapsed, hidden between the liver and the colon. When this is the case the fingers must be introduced, and passed along the under-surface of the left lobe; the first structure they touch after leaving it must be the stomach.

The opening in the stomach should preferably be near the cardiac end; but if this causes the least traction, it must be made in the most convenient situation.

The further stages depend upon whether the stomach is to be opened at once or not. If the time can be afforded, there is no doubt the latter is advisable; even twelve hours will often seal the surfaces together: in two days the lymph will be comparatively firm; but when the patient is exhausted from the combined effects of carcinoma, starvation, and shock, it very often happens that this is impracticable, and that food must be introduced at once. Rectal enemata will maintain existence if the patient is already well nourished and is kept perfectly warm in bed, without being exposed to injurious influence of any kind; but under conditions such as these they are exceedingly unsatisfactory. The temperature is the best guide: if it is in the least subnormal there is no time to waste.

If it is not intended to open the stomach for some days, it need only be held up against the edges of the abdominal wound; the serous surfaces grow together, and by the time the supporting structure is removed, the lymph is sufficiently firm. Two hare-lip pins will answer; the serous and muscular coats of the stomach are pinched up together and transfixed, and the ends of the pins (protected with a piece of drainage-tubing) are allowed to rest upon the skin.

Sutures are advisable in most cases. One must be passed through the serous and muscular coats of the stomach opposite the centre of the opening. It gives something to hold the stomach by, so that it does not fall back, and later it marks the spot for the puncture. The others must traverse the whole thickness of the abdominal wall, but only the serous and muscular coats of the stomach. They may be interrupted, two long ones or four short ones being used, or continuous, so as to secure adaptation all the way round, the skin in either case being protected by passing a piece of rubber tubing under the projecting loop. In addition a second set of sutures may be inserted, securing the serous and muscular coats of the stomach to the cut edges of the parietal peritoneum and the skin. If the stomach is to be opened at once or within twenty-four hours, this is essential.

The wound should be protected with some non-adhesive dressing, and covered with abundance of wood-wool. The patient must be kept as warm as possible and fed by means of enemata; a certain amount of stimulant is always advisable (in spite of its tendency to make the patient lose heat), as not unfrequently the heart suddenly gives out. Traction upon the stomach alone is sufficient to make it stop, and when the patient's reserve is almost used up the greatest care is required.

According to Howse, five days is the usual time for opening the stomach. The extent of the adhesions depends partly upon the strength of the patient, partly upon the amount of disturbance the structures have been subjected to and the accuracy of adaptation. Occasionally, when the exhaustion is very extreme, as in advanced carcinoma, they hardly form at all. No anæsthetic is required; the suture that has been left marks the spot (otherwise it may be very difficult to make it out), and all that is needed is a puncture with a very sharp double-edged tenotomy-knife. A blunt one may fail to penetrate the mucous coat. A small catheter is then introduced by the side of the knife: this is withdrawn and some warmed and peptonised milk injected. The catheter should be secured in the wound, or it may be difficult to find the opening again; the irritation of the acid gastric juice can be prevented to some extent by using dressings soaked in carbonate of soda. After a time the size of the catheter may be increased, or it may be replaced by a soft red rubber tube provided with a flange, somewhat similar to those used for tracheotomy.

2. *Gastroduodenostomy or gastrojejunostomy* may be required in cases of stenosis of the pylorus, whether simple or malignant. Of the two the latter is to be preferred, as the first loop of the jejunum is covered over with peritoneum and can be brought without any undue traction into contact with the anterior surface of the stomach. A communication is made between the two viscera, and their serous and muscular coats accurately sewn together all round. In order to effect this they must be brought well up into the wound,

and, as Barker recommends, the suturing on the posterior surface should be completed as far as possible before any opening is made. It is probable, however, that in any operation of this kind in the future, either Senn's decalcified bone-plates (as described in operations upon the intestine) or some modification of them will be employed, as the adaptation is much more perfect and secure, without requiring one-fourth of the time; and it does not seem unlikely that this operation will almost supersede pylorectomy for carcinoma.

3. *Gastrotomy.*—By this is understood a simple incision in the wall of the stomach, for the purpose of removing a foreign body, dilating the œsophagus or pylorus, or curetting a carcinoma. The wound is a temporary one, and, after the purpose for which it was made is accomplished, is sewn up again. It must not be confused with laparotomy, which is confined to an incision into the abdominal cavity.

The stomach (unless there is some contra-indication) should first be washed out with a solution of boracic acid. Some may be left in if it is thought desirable that the cavity should be partially distended, but it is not in any way necessary. The parietal incision may be in the middle line or parallel to the costal margin on the left side, having its centre opposite the eighth or ninth rib. The stomach is found in the same way as before; brought to the surface and secured by two temporary sutures passed through the serous and muscular coats. The incision (which should not be made until every precaution has been taken to prevent any of the contents escaping) should be parallel to the vessels, vertical, that is to say. Afterwards the wound is secured by Lembert's suture; the stomach allowed to fall back; and the parietal incision closed in the usual way.

This may be required for the removal of a foreign body from the stomach or the lower end of the œsophagus; in cases of (non-malignant) stenosis of the pylorus or œsophagus (Loreta's operation, or dilatation of the contracted orifice from within by means, first of one finger, then of two, until it feels as if further distension would result in tearing); or for the scraping away of a malignant growth from the interior by means of a curette. So far as the operation is concerned it has proved very successful, but, of course, in the last-mentioned case, it can only be palliative in its action, and it is questionable whether some form of anastomosis with the intestine would not be preferable.

4. *Pylorectomy.*—In this the pylorus, with the adjacent parts of the stomach and duodenum, is excised, and the orifices approximated and fastened together with sutures. It is only required in cases of malignant disease, and then is only advisable when there are no adhesions or enlarged glands. If either of these complications is present, the removal of the growth will not cure the patient; and gastrojejunostomy affords as fair a prospect of relief with infinitely less risk. The pylorus must be isolated; the great omentum detached and ligatured in successive portions without endangering the blood-supply of neighbouring structures more than can be helped; the stomach opened and divided on the proximal side of the growth; and the duodenum on the distal. As soon as the mass is removed and all bleeding stopped, the wounds must be secured. As that in the stomach is much the larger of the two, it must be sewn up independently, until the orifice is contracted to the size of that of the duodenum. Many of the sutures may be passed from the inner surface; but, if possible, a second

set, joining the muscular and serous coats only, should be used as well. The operation has on many occasions taken several hours to perform; the number of sutures, if leakage is to be prevented, is enormous; the risk of gaping, especially where the peritoneal coat is not firmly adherent, is very great, and in by far the majority of instances the patient has either never rallied from the shock or has died shortly after from peritonitis.

5. In addition to this, gastrorraphy has been performed for perforating ulcer, the stomach being drawn forwards and the opening secured by sutures.

SECTION III.—HERNIA

THE escape of any of the viscera from its natural cavity is a hernia, provided it passes through an abnormal or accidental opening; but when unqualified, it is usually applied to the abdomen only. Internal hernia, in which a portion of the intestine is displaced inside the peritoneal cavity, is treated of with internal strangulation.

Causes.—These may be immediate or predisposing.

1. *Immediate or exciting causes.*—Hernia may nearly always be traced to the action of the abdominal muscles upon the viscera. It is more common among those who follow laborious occupations with constant heavy strains, than among those who lead a sedentary life, and it may be caused either by a single sudden effort or by continual repetition; even the straining in calculus of the bladder, or phimosis, is sufficient in those who are predisposed to it.

2. *Predisposing causes.*—Certain parts of the abdominal wall are naturally weaker than the rest: the umbilicus, for example, the crural ring, especially in the adult female, and the inguinal canal. In many there is a distinct bulging over the internal abdominal ring on coughing or straining: the internal oblique is poorly developed; or it does not arise from Poupart's ligament in front of this spot; the openings are large, or the conjoined tendon and the intercolumnar fascia are thin and weak.

Congenital malformations are not infrequent: late descent of the testes, for example, and patency of the tunica vaginalis; defective development of the diaphragm; or separation of the recti from each other in the linea alba.

In other cases there are acquired defects: the muscles have been torn or bruised; the fasciæ divided in operations; inflammation has caused softening and yielding of the wall; there has been repeated distension as in pregnancy or ascites; or sudden emaciation has led to absorption of the fat from over the crural ring.

The length of the mesentery is of some assistance. In infancy it measures one-fifth of the body (taking it from the root to the convex border of the intestine), at puberty one-eighth, and in adult life one-ninth; and its root lies much lower on the right side than on the left, which accounts in part for the greater frequency of the congenital variety upon that side. But probably it is never too short to allow a hernia to descend. Instances are recorded in which a piece of intestine, which normally could not touch the internal ring, has been forced into it by accidental pressure.

The general laxity of the pelvic peritoneum during child-bearing may account in some measure for the frequency of femoral hernia at that time of life: and there is no doubt that the descent of a hernia for the first time is greatly favoured by diarrhœa and other disorders which might reasonably be imagined to cause relaxation of the mesentery.

Prolapse of the mesentery is very important. It rarely occurs before late adult life and is always associated with a peculiar and easily recognised bulging of the lower part of the abdomen. The epigastric region is flat and hollow: below there is a great projection, not only in the middle line, but at the sides, forming a sort of triple bulging, due to the yielding of the muscles at their weakest part. This always means that the root of the mesentery has glided down, possibly owing to the degeneration of the suspensory muscle and ligament at the end of the duodenum, and that any measure for radical cure that aims at merely strengthening the abdominal wall must fail. Very often in these cases prolapse of the kidneys and of other viscera occurs at the same time.

Hernia, there is no doubt, is hereditary, or rather the conditions that predispose to it. Men are more liable to it, especially the inguinal forms, than women; on the other hand, the femoral and umbilical are more common in the latter. Owing to the frequency of the congenital inguinal variety, hernia is met with very often during the first year of life; and at this time it is more common on the right side than on the left. Then the number falls off rapidly and continues to diminish until after puberty. From that time it grows larger, until it has been said that one in four of those over sixty years of age suffer from it. Prolapse of the mesentery, as years advance, tends to equalise the frequency on the two sides, so that at five and forty left hernia is as common as right, and a little later double hernia more common than either alone.

ANATOMY

A hernia is generally enclosed in a sac continuous with the peritoneum, and surrounded by prolongations of the various layers that form the wall of the abdomen.

1. *The sac.*—Except in cases of rupture of the wall of the abdomen, hernia of the bladder, and sometimes of the colon, a peritoneal sac is always present. In congenital inguinal hernia it exists already: the hernia descends into the open vaginal process of peritoneum in front of the spermatic cord. In all others it is formed gradually by the pressure of the viscera upon the inner surface. At first there is a simple depression with a wide orifice: then, as the protrusion extends farther and reaches more yielding structures, the peritoneum becomes stretched and displaced until it forms a globular ac communicating with the normal cavity by a narrow neck. In this stage he lining is still unaltered, merely thrown into folds at the neck owing to he shape of the parts, and the contents can only be strangulated by the contraction of the structures that lie around. Later, the neck becomes hickened, hardened, and condensed: the folds grow together and fuse with he fibrous structures outside until they form a ring of dense cicatricial ssue; and this keeps on contracting, until sometimes, if the hernia is

prevented from descending, it closes completely. Not unfrequently, however, before this stage is reached, while there is still a small aperture in the centre of a dense fibrous ring, a knuckle of intestine is squeezed down through it, and is so tightly held that the circulation in it is stopped: in other words it is strangulated.

Sometimes more than one constriction is present. The original neck may have been pushed down by a fresh protrusion, and a second neck formed above it; or the sac may have been constricted at the same time in two places, at the internal and the external rings for example; or, in the congenital variety, a constriction may make its appearance in the tunica vaginalis on a level with the upper part of the testicle, so that the cavity assumes the shape of an hour-glass; and anyone of these may be the seat of strangulation.

Diverticula also are sometimes found, especially in the congenital form, and not unfrequently they are very large, extending upwards in the front wall of the abdomen between the muscles, or behind them in front of the fascia. These intraparietal sacs are of great importance, for if a hernia descends it may easily be returned into the diverticulum instead of the abdomen, leaving the strangulation, if one is present, unrelieved.

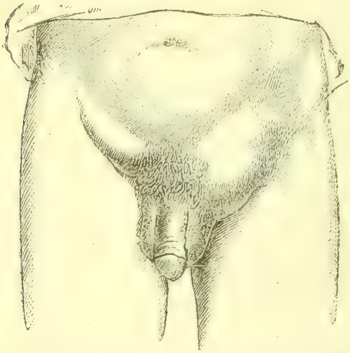

FIG. 351.—Oblique inguinal hernia. Bubonocele on right side, but passing through external ring on left.

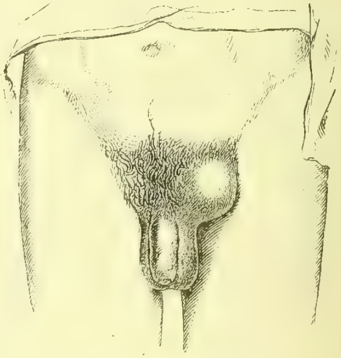

FIG. 352.—Direct inguinal hernia.

Hydrocele of the sac is a very rare condition. Several pints of fluid may collect in it when the orifice is temporarily obstructed by a hernia; but the term *hydrocele* should be reserved for those cases in which fluid accumulates after the neck of the sac has been completely and permanently closed. It has been met with in femoral and in inguinal herniæ, and it may render the diagnosis very difficult.

2. *The contents.*—With the exception of the pancreas, all the viscera of the abdomen have been found in hernial sacs at one time or another; the most common is the ileum, especially the last few feet, and then the omentum. The cæcum and colon, which come next, are much more rare, and the others are only met with in congenital malformations.

When the protrusion consists of intestine it is called an *enterocele*; when omentum, *epiplocele*; if both are together, *entero-epiplocele*. In this case the intestine nearly always lies behind the omentum, concealed by it; in some rare instances, however, it is in the middle, in a kind of inner sac. Cystocele, gastrocele, and other similar terms, are occasionally used.

3. *The structures that cover a small hernia* are but little changed; they merely stretch and yield, and the sac can still be easily reduced. As the size increases, however, this becomes different. The subserous fat wastes and grows fibrous; the sac becomes adherent; it is thickened in some places from the irritation of the truss, and thinned in others; the coverings become matted together, so that their structure can no longer be distinguished; and at length the parts around are hopelessly distorted from the continued traction, so that, for example, the internal inguinal ring is dragged opposite the external.

Symptoms.—A hernia often causes griping and colicky pains in the abdomen, probably from the way in which it drags on the mesentery and impedes peristalsis; while dyspepsia and a feeling of discomfort on exertion and after meals are nearly always present; but in many cases either this is not noticed or is put down to other causes. The character of the swelling depends upon its contents. When the main bulk consists of intestine the surface is uniform and elastic; a distinct impulse can be felt when the patient coughs or strains; and if it is of any size and the walls are not too tense, it is resonant on percussion. Omentum, on the other hand, feels hard and doughy; the surface is uneven, and though there is a certain degree of impulse in most cases communicated from the abdomen, the swelling does not become tense and expand in all directions in the same way as intestine. The method of reduction, too, is different; intestine slips back suddenly, often with a peculiar gurgling, and the patient experiences at once a feeling of relief; omentum disappears more gradually, and if both are down together, is almost always the last to go.

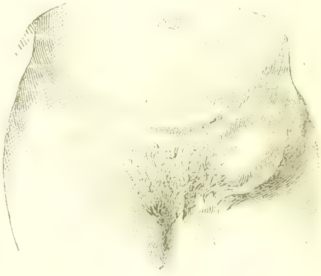
FIG. 353.—Femoral hernia.

The sac can only be reduced in the early stage of a hernia, before it has acquired a definite shape and contracted adhesions to the surrounding structures.

Treatment.—A hernia must be prevented from descending, either by means of a suitable contrivance (a truss or belt), or by closing the aperture through which it has escaped. The former is only palliative, although, if it is adopted sufficiently early in children, and carried out with proper care, a permanent cure may generally be looked forward to; the latter is known as the radical cure, and aims at allowing the patient to dispense with a truss altogether.

1. *Trusses.*—A truss consists of a pad or cushion attached to a metal spring surrounding the body, so arranged with straps that its position remains unaltered in the most varied movements. Inelastic trusses, made of a leather band (as the Moc-Main truss) instead of a spring, are of use in large irreducible herniæ, but cannot be relied upon for ordinary work; they fail to exert sufficient pressure when the patient is stooping, the position of all others in which the hernia most easily descends.

The pad is generally made of cork, covered with flannel, linen, and wash-leather; but rubber, water, and air cushions may be used where pressure is painful or the surface irregular. For an oblique inguinal hernia it should be pear-shaped, about three inches long, two inches at its broadest part, and three-quarters of an inch in thickness; the outer surface is flat, and has two studs upon it for the attachment of the straps; the inner is slightly convex, looking upwards as well as backwards, especially when the abdomen is protuberant, and lies upon the internal ring and the inguinal canal, not touching, though it may come quite close to, the pubic spine. If the hernia is congenital, the pad should be prolonged downwards between the scrotum and the thigh, tapering off gradually (rat-tail truss); and if it is direct, or if it is an old oblique one with the rings dragged nearly opposite each other, a cross-bar may be added over the upper border of the pubic symphysis, so that the pubic spine lies, as it were, in a recess. In these cases, however, it is usually advisable for the patient to wear a double truss; very often, especially in the direct form, there is a certain amount of weakness on the other side as well; the inconvenience of a double truss is no greater than that of a single one; and if the two pads are held together by a strap or cross-bar over the pubes, the security is very much greater.

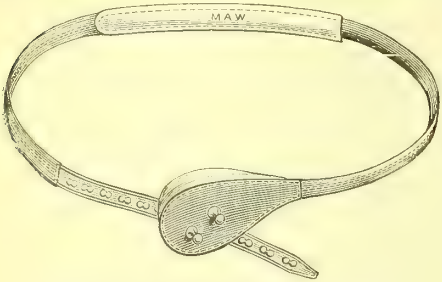

Fig. 354.—Cole's truss for inguinal hernia.

Wood's pads are based on a different principle; they are made of boxwood, ivory, ebonite, or some other firm non-absorbent material, and they are shaped so that the pressure falls, not upon the opening, but all round it.

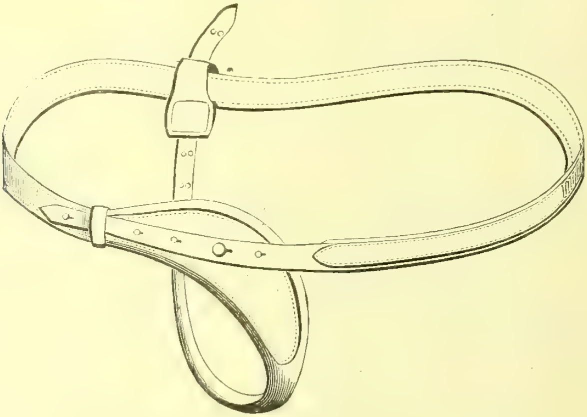

Fig. 355.—Single circular spring truss for scrotal hernia.

The pad for an oblique inguinal hernia, for example, is cut like a horse-shoe, with one side (that which covers the inner pillar) longer than the other; the spring is fixed to the geometric centre; the spermatic cord and the pubic spine fit themselves into the interval between the sides of the shoe; and the rupture is prevented from descending by the tension across the opening; that for a direct hernia is in the form of a ring, the centre of which corresponds to the axis of the hernial opening. In either case the tissues project upwards in the centre, where there is no pressure; and this and the double bearing greatly diminish the chance of slipping.

For a femoral hernia the pad is smaller, bevelled a little on the outer side to avoid pressure upon the femoral vein, and above so that it may fit well up under Poupart's ligament and bring the walls of the canal together. If an operation has been performed, and Gimbernat's ligament freely divided, this is not enough; in such cases a thigh-belt, laced up around the upper part of limb, with a triangular pad over the saphenous opening and filling up the greater part of Scarpa's triangle, is required, and even this will only prevent the hernia increasing in size.

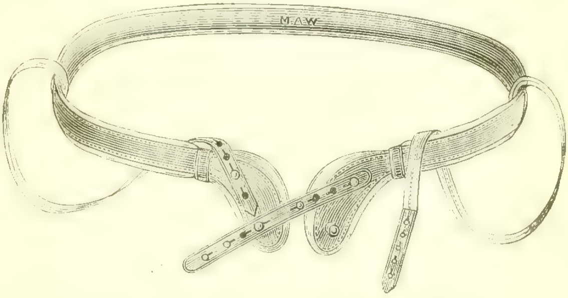

Fig. 356.—Double femoral truss with circular spring.

Umbilical herniæ are best kept in place by a shallow concave plate, which at the same time supports the lower part of the abdomen. Nipple-shaped projections only make the opening larger. Pads with spiral springs are very comfortable, but cannot be relied on where strength is required, as they are apt to yield if the strain is severe.

The pad in most cases is rigidly attached to the spring; but in some, as in Salmon and Ody's, there is a ball-and-socket joint, and in others it can be shifted upwards or downwards and fastened in any position. The spring passes round the rim of the pelvis, fitting closely to the figure, just below the iliac spines, and above the glutæi. If the truss is a single one the free end is beaten out flat, and shaped so as to cling round the opposite hip. Its strength is regulated by the muscular condition of the patient and the size of the rupture, and it should always exert slight pressure, even when the body is at rest. Where the employment necessitates great exertion, it may be advisable to have two trusses of different strength. The under strap, which prevents riding up, should always be fastened to the lower stud, and in the erect position should be moderately tight.

Measurements.—In young adults with a flat abdomen it is sufficient to give the measurement from the pubic symphysis to the anterior superior spine, and from this round the back to the opposite one; but in all other cases the exact line of the truss should be followed, from the ring to the spine of the ilium, from this to the opposite one, and then back to the ring again; and when there is any peculiarity of structure, such as an oblique pelvis or pendulous abdomen, this should be mentioned, and the direction in which the pad is to press carefully noted. The vertical distance of the internal ring, from a line joining the two anterior superior spines, is often useful. In addition, full particulars must be given as to the size and nature of the hernia, the side on which it is situated, the muscular condition and the employment of the patient, and the age and sex.

To test the truss the patient should be seated on the edge of a chair, with the knees separated so that the structures around the rings are relaxed, and directed to strain downwards. If the rupture does not escape, the pad fits the opening and the spring is sufficiently strong. Too strong a one is injurious, as its pressure tends to cause absorption of the tissues beneath. For the first week the truss is generally exceedingly uncomfortable, but it must be worn all day, and, in some instances, at night as well, though a lighter one is sufficient then. In any case it should be adjusted of a morning while the patient is still lying down, care being taken that the hernia is completely reduced. If the skin becomes tender, it may be bathed with eau-de-Cologne, and dusted with violet-powder. Waterproof trusses, covered with india-rubber, are required for bathing.

Innumerable modifications have been devised for special herniæ. Salmon and Ody's truss answers exceedingly well for some kinds of umbilical and direct inguinal hernia, and for cases in which a clinging truss is irksome. It consists of a semi-circular spring with a broad flat plate on the sacrum, and a movable pad over the protrusion; and it should be adjusted around the opposite side of the trunk. Pads filled with sand, or moulded on the spot itself, are often of use if the skin is tender and a water-pad is not available. Irreducible hernia may be enclosed in a hinge-cup, made of a rim-plate covered with leather, or supported in a laced bag truss, in the hope that the size may be diminished by the continued pressure. Belts may be required for umbilical or ventral protrusions. A skein of Berlin wool may be used for the congenital hernia of children, as described by Coates, of Salisbury. It consists of about twenty threads tied together at intervals to prevent their separating, with the loop-end of the skein placed over the abdominal ring, the other end is carried across the pubes round the opposite side behind the body, and brought down in the fold of the groin to pass through the loop; it is then taken between the thigh and the scrotum under the limb, and brought up behind it to be fastened to the horizontal portion. The loop, with the skein passing through it, forms a pad resting on the inguinal canal; the wool is sufficiently elastic to exert reasonable pressure, and cannot gall the skin. Moreover, it can be renewed as often as required, and when it is thought that the truss may be left off the strength can be gradually reduced by diminishing the number of strands.

IRREDUCIBLE HERNIA

A hernia is irreducible when, without the circulation or the passage of fæces being impaired, it cannot be returned into the abdomen.

In a few cases this is due to changes in the tissues around, or in the sac; nearly always it is the result of the condition of the rupture itself. The size may be the obstacle, as in large neglected scrotal or umbilical herniæ. The shape may prevent it, especially if it consists of omentum; this assumes the form of an inverted mushroom, tough and fibrous at the neck, wide and expanded in the body of the sac. Much fluid renders it difficult, owing to the way in which it protects the intestine from manipulation; but this is usually only temporary and can be easily cured by tapping. Adhesions are exceedingly common and are much more serious. They may form between the sac and its contents or between the structures inside, so that they cannot change their relative position. Finally, in some cases it is due to anatomical peculiarities, such as the absence of a peritoneal covering, as in hernia of the bladder.

Irreducible herniæ, if left to themselves, tend to increase in size until almost the whole of the intestines may find their way into the sac. Even when they are small they cause extreme discomfort; dyspepsia, dragging pains, and colic are of frequent occurrence, especially after food, from interference with the movement of the stomach; when large they become a serious source of danger. Constipation may lead to the accumulation of fæces, and this to obstruction; strangulation may occur, either gradually as in consequence of obstruction, or suddenly from the descent of a fresh portion. This is especially frequent in the femoral epiplocele of women; irreducible omentum is in them of common occurrence, and from its giving rise to no serious symptoms, often receives no attention; but the band running down from the stomach to the crural ring acts as an inclined plane, which, as the intestines sweep round the peritoneal cavity, guides them infallibly into the orifice. Besides this, an irreducible hernia is constantly liable to become inflamed, as, owing to its size, it is very much exposed to injury; and even rupture of the intestines or of the sac may occur from accidental violence.

Treatment.—This must be guided by the age and condition of the patient and the size and nature of the rupture.

Where the patient is old and feeble, not likely to undertake vigorous work, the hernia should be enclosed in a bag-truss, laced up on one or both sides, or in a cup made of soft leather supported by a metal rim. Sometimes, as suggested by Bryant (fig. 357), the pad may be made of metal moulded on a cast taken from the hernia when it is at its smallest. In this way the rupture can always be prevented from increasing, and sometimes can be materially reduced in size.

In younger people, if the rupture consists of omentum only, an attempt may be made to reduce the size by procuring absorption of the fat. The patient should be confined to bed, on diet consisting very largely of lean meat; an ice-bag should be placed upon the swelling, and small doses of iodide of potash given. Sometimes under these conditions the size is so much reduced in the course of ten days or a fortnight that taxis succeeds under an anæsthetic; but the smallest adhesions are sufficient to prevent it. If this fails a truss may be fitted over it, but if there is much inconvenience either from this or from gastric trouble; or if the patient is, as most of them are in the lower classes of life, too careless to be trusted; or if they are likely to be placed in circumstances in which they could not at once obtain advice, it becomes questionable whether an operation should not be undertaken.

Great difficulty is experienced sometimes with sailors, who have allowed an enterocele to attain an enormous size, and perhaps become extensively adherent before applying for relief. In such a case, however, an operation should never be lightly undertaken; it usually involves prolonged dissection, and it may be found after all impossible to complete it.

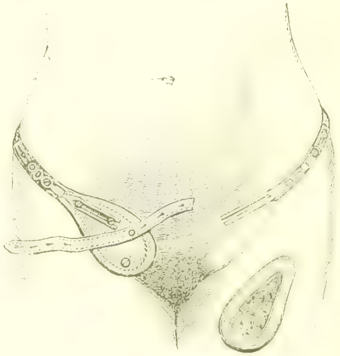

FIG. 357.—Pad and truss for irreducible hernia.

Obstructed Hernia

A hernia is obstructed or incarcerated when, without the circulation being affected, the passage of the fæces is arrested, either from accumulation in the interior or from the impaction of scybala. This can only happen with large herniæ and probably only with those that contain some portion of the colon; the contents of the small intestine are too liquid.

The most typical example occurs in the neglected umbilical herniæ which are so common after middle life in women who have had large families. A large pendulous mass hangs down over the edge of the umbilicus, sometimes tympanitic, but more often hard and uneven; generally speaking, it is not very tender, though it is often the seat of a griping pain, and the coils of intestine can be felt and even seen working in it. Constipation is complete unless the sigmoid flexure and the rectum contain fæces; the tongue is thickly furred and inclined to be dry; the appetite is lost; nausea is common, though the patient seldom is actually sick; and although there is great discomfort, and perhaps painful colicky spasm in the abdomen, there is an entire absence of the depression characteristic of strangulation. The danger is that the veins may become compressed, and the return of blood impeded, until the congestion passes into strangulation. I have known a patient suffer from an obstructed umbilical hernia on four occasions, at intervals of a few months; the last time the movements of the intestine in the sac suddenly ceased, and the patient began to sink; strangulation had set in.

Treatment.—Position in these cases is most important; so long as the hernia hangs down it is hard, tense, and often œdematous at the lowest part; when it is raised over the orifice from which it has escaped it becomes soft and flaccid. This should be assisted by warmth and kneading day after day, so as to empty part of the bowel; the colon should be thoroughly evacuated with enemata; the diet small in quantity but fairly nutritious; and opium only given if there is severe pain; afterwards the bowels must be kept relaxed until the size of the hernia is reduced again.

Inflamed Hernia

Irreducible herniæ, especially those containing omentum, may become inflamed from the pressure of an ill-fitting truss, from taxis, or other forms of injury; much more rarely from the impaction of fæces, or as a result of enteritis. In most cases the sac is empty, but the walls are thickened and softened; the endothelium disappears; in its place there is a roughened surface coated with lymph; and all the contents are congested, swollen, and œdematous. Sometimes the sac is filled with a turbid fluid. Suppuration, fortunately, is rare (unless the bowel is strangulated); nearly always the inflammation subsides, and the lymph becomes absorbed, leaving a few adhesions between the structures inside.

The skin over the sac is reddened, œdematous, and adherent to the fascia beneath; the pain is very severe, with marked tenderness on pressure; and the sac feels swollen and tense, but there is still an impulse on coughing, and sometimes, in a large hernia, the finger can be passed along the pedicle for some distance. The patient is ill and feverish, with nausea and abdominal tenderness, especially in the region of the sac; but there is no collapse; the face is not anxious or the tongue dry; and the pulse has not the small wiry character characteristic of strangulation.

The treatment is the same as in local peritonitis: the patient must be placed in bed and kept on milk diet; small doses of opium may be given every few hours at first, then at longer intervals. An ice-bag should be placed over the swelling, until the temperature is reduced, but in old people it should not be kept on longer than this. Afterwards the bowels must be carefully regulated and the hernia protected from further injury.

STRANGULATED HERNIA

A hernia is strangulated when it is so tightly constricted that the circulation is stopped. The whole circumference of the gut may be caught; or only one side of a loop, as in Littre's hernia, so that the channel is not completely closed: or the intestine itself may be free, and the omentum only involved; the symptoms are essentially the same, though they differ in intensity.

Causes.—Strangulation may occur during perfect health, suddenly and without warning; in many instances, however, there is a history of some previous intestinal trouble, dyspepsia, diarrhœa, or colic; and it is possible that this increases the liability, either from the general malaise and want of tone in the abdominal muscles, or from the relaxed state of the mesentery.

The immediate cause is nearly always a sudden effort, lifting a heavy weight, for example, or straining at stool with the thighs in such a position that the abdominal rings are relaxed and unprotected; but strangulation may be gradual, and it has been known to occur during sleep. Where there is a congenital sac, the hernia may be strangulated the first time it descends, and then, especially if the patient is a young adult, the effect is very characteristic: a loop of intestine is suddenly squeezed through a narrow channel into a wider space beyond, and the circulation is stopped at once. The same thing happens if the sac is an old one and the hernia has not descended for some considerable time, and very often these cases are the worst, from the unyielding nature of the tissues at the neck. When there is an irreducible hernia already, especially if it consists of omentum, and a fresh loop is squeezed down behind it, the constriction is rarely tight enough to cut off the circulation at once; the veins only are compressed, and blood continues

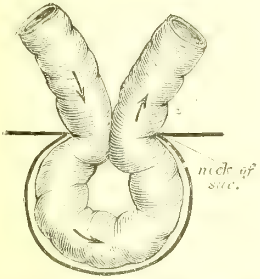

FIG. 358.—An unstrangulated hernia.

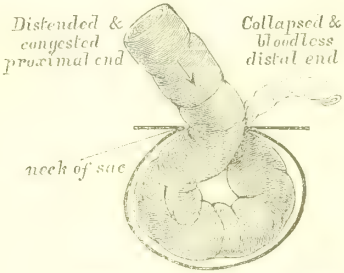
Distended & congested proximal end
Collapsed & bloodless distal end
neck of sac

FIG. 359.—A strangulated hernia.

to enter until the walls of the intestine become black and almost solid from the amount they contain. The same occurs when a hernia that is already obstructed becomes strangulated, only the onset is then even more gradual.

In recent hernia, in which the sac has as yet no existence of its own, but is merely a temporary depression of the peritoneum, the constriction is necessarily caused by the tissues outside it. In older cases it may be the same, but more often the hernia is caught by the neck of the sac, which has become hard and unyielding. In rare instances the intestine is strangulated by bands inside the sac passing across from one wall to the other, or by its slipping through an accidental opening in a piece of unreduced omentum.

Whether the strangulation is rapid or slow, the effect is always the same; the only difference is in the length of time and the amount of congestion.

Pathological appearances.—The intestine may be free, or adherent to the body or the neck of the sac. Its colour may be but slightly changed; generally it is redder than natural, with distended veins, and sometimes it is purple and almost black, with blood extravasated between its layers. In the early stages its walls are firm and dense, thicker than natural and rigid from the congestion. Later, as its vitality begins to fail, the surface becomes dull and loses its polish; it may even look granular or be coated over with lymph; later still the walls become soft and flaccid, yielding to the least pressure, the colour changes to an ashy grey or green, and gangrene sets in. Sometimes the sloughing commences in the loop; more often, especially when the edge of the constriction is sharp, like Gimbernat's ligament, the mucous membrane gives way first in a line corresponding to the band, and the fæces are extravasated into the sac.

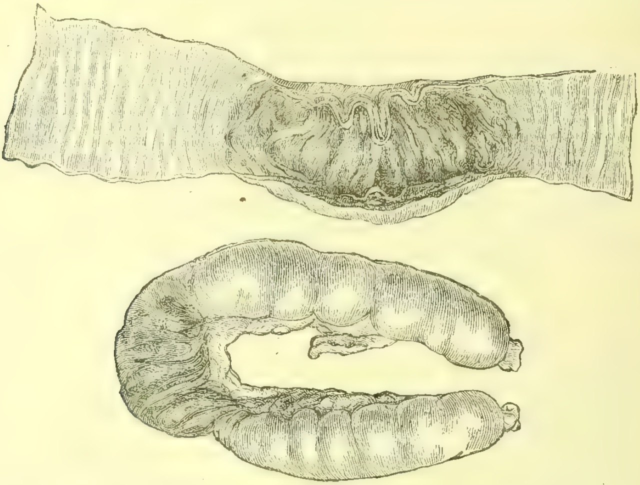

FIG. 360.—Extreme venous congestion and interstitial hæmorrhage, the effects of severe strangulation of the bowel.

If the strangulation is relieved before this, a deep groove may be found running round the whole or part of the bowel, often so marked that traces of it are present for weeks. Above the strangulated loop the intestine is distended and deeply congested; below it is empty, pale, and flaccid. At the ring itself the peritoneum may be unaltered if the hernia is recent or thickened and opaque if it has descended many times. If the intestine is inflamed it is usually firmly adherent at the neck; unless it has given way inside the abdomen above the stricture, or inflammation has been caused by reducing some of the contents of the sac, these adhesions protect the general cavity of the peritoneum so thoroughly that anything more than local peritonitis is exceptional.

When omentum is present it undergoes similar changes, whether it has recently descended and is soft and delicate in structure, or is old, tough, and fibrous. The blood-vessels become distended; it swells up and becomes œdematous; and unless the constriction is relieved it grows darker and darker until it forms a slate-coloured, offensive, and putrid mass.

The sac nearly always contains a certain amount of fluid, which varies according to the condition of the hernia and the vigour with which taxis has been applied. When quite recent it is bright and clear; as the congestion increases it becomes blood-stained from the giving way of small vessels, especially if any force is used; and occasionally there are coagula. Flakes of lymph are sometimes present as well, and in the worst cases, when gangrene has set in, it is filled with pus of the most offensive description and mixed with gas. Occasionally, even when there is no perforation, there is a distinctly fæcal odour, just as there is sometimes in abscesses of the abdominal wall.

A peritoneal sac is very rarely wanting, but in the case of the colon there may be only a partial one. Sometimes it is so thin that the contents can be seen through it without difficulty; in old cases, especially when a truss has been worn, it may be so thick that layer after layer of fibrous tissue is divided under the impression that each is the last. In a few instances portions of the subserous fat still retain their connection with it, so that it has a deceptive resemblance to omentum. In recent hernia it can be isolated from the structures around; in old ones, however, it is closely incorporated with them, especially at the neck.

The tissues outside the sac may be unaltered; but not unfrequently they are bruised or inflamed from the severity of the taxis. When the contents of the sac are gangrenous and suppuration has set in, the appearances are simply those of an abscess.

Symptoms.—The symptoms of strangulation are collapse, vomiting, and pain. Where the patient is young and in vigorous health, and where the strangulation is sudden and complete, the symptoms begin instantaneously and with great severity; where, on the other hand, the patient is feeble and anæmic, or where there is already a large epiplocele protecting the intestine from too great pressure, they set in very gradually, and some hours may pass before they reach their full intensity. In addition, it is not improbable that the part of the intestine involved is of some importance. The collapse and the vomiting are due, entirely at first, to the effect of the strangulation upon the nerves, especially upon the great plexuses in the abdomen; and though, perhaps, to a less extent, this is true of the pain as well. It is not improbable, as Treves has pointed out, that the jejunum with its muscular walls, copious blood-supply, well-developed nerve-plexuses, and vigorous functional activity, would resent an injury more energetically than the lower ileum, where the muscular tissue is more scanty, the blood-supply less free, and the functional activity less pronounced.

The aspect of the patient changes almost at once. The face is drawn and pinched, the cheeks blanched, the lips white, the eyes sunken and surrounded by dark rings, and the forehead covered with perspiration; the patient looks prematurely old and the expression is that of intense distress. The skin, especially on the extremities, is cold; the temperature is subnormal, and the pulse small, feeble, and compressible, often as many as 120 and even 140 beats in the minute. The tongue at first is white, but it soon becomes dry and brown; there is intense thirst, and the amount of urine secreted is far below normal. Like the other signs of collapse, this is due to the disturbance of the abdominal nerve-plexuses, and is acute in proportion to the extent to which they are involved.

Vomiting may come on at the moment of strangulation, or not until later. When it has commenced it rarely ceases, its character gradually changing as the contents of the stomach, duodenum, and small intestine are successively ejected. At first it may consist of undigested food; very soon it becomes bilious in character, and, after three or four days' strangulation, it comes up in great gushes, a dark brown, muddy liquid, intensely offensive in odour, sometimes distinctly fæcal. It is probable that the peristaltic action of the intestine is reversed, although apparently in intestinal obstruction, when the proximal part of the intestine is thrown into violent colic, the contents, even of the ileum, can be ejected without.

Pain varies considerably. In some it is local and comes on at the moment of descent, caused by the stretching of the tissues around the sac, and when the strangulation is sudden it may be very severe. In others it is scarcely noticed, and the patient may be almost unaware of the existence of the rupture. A fixed dragging pain, referred to the umbilicus, is nearly always present, probably due either to traction on the mesentery or to the effect upon the great nerve-plexuses. Besides these there are usually wandering colicky pains all over the abdomen, caused by the violent and irregular movements of the bowels above the strangulation, and made worse by any attempt at taxis.

Constipation is nearly always present, caused not by the obstruction but by the effect upon the nerves, for even when the sigmoid flexure is full the bowels are rarely opened after strangulation has set in. Exceptions to this, however, sometimes occur, and there may be one or two motions when the lower bowel is full.

In Littre's hernia the interior of the intestine is sometimes closed by the kinking opposite the strangulation, but often it is patent all the way through. Constipation, however, is the rule in this as well as in the other forms, although in a few cases (three out of fifty-three) Treves found that there was diarrhœa, and in several of the others the bowels responded to aperients.

The local symptoms are generally very prominent, but occasionally the patient is not aware of the existence of a hernia, although it may have been in a state of strangulation for forty-eight hours. Obturator and sciatic herniæ especially are so small and so deeply placed that the tumour often cannot be made out, even after careful examination. If the hernia is an old one, that has been down many times already, the size is most likely increased, but it may be impossible to obtain exact information.

Small herniæ, when strangulated, are hard and tense, or doughy if they contain omentum; large ones, especially those that are irreducible, are often fairly soft, as the strangulated part may be simply a loop at the back covered in by the rest. In many cases the tumour is dull on percussion, although it contains intestine, partly because of the liquid in the sac, partly because the amount of air is so small and the walls so thick.

Absence of impulse on coughing or straining is the chief local feature; the contents of the sac are shut off from the abdomen, and nothing more can enter. In large herniæ the impulse can sometimes be felt as low down as the neck; there it ceases abruptly. The skin may be tender, but, as a rule, this is not marked unless the sac is inflamed or taxis has been too vigorous.

As the case progresses and gangrene becomes imminent, the constitutional symptoms grow more distinct. The vomit is intensely offensive, or dark, like coffee-grounds, and it comes without effort in great gushes; there is constant and painful hiccough; the pulse becomes intermittent; the abdomen begins to swell and become tympanitic; it is not very painful as yet, but the whole surface is tender; the mind begins to wander; the face becomes more haggard; the patient tosses restlessly about, growing colder and colder, and at length sinks exhausted. Occasionally, before the end, the local pain ceases; the tenseness of the tumour disappears; and it slips up almost of itself, making the abdominal symptoms tenfold worse. More frequently the swelling increases, and becomes resonant as the gases of putrefaction collect; the skin becomes livid and œdematous, and at length gives way, allowing the intensely fœtid contents to escape externally, and leaving, if the patient survives, either a fæcal fistula or an artificial anus.

It very commonly happens, especially in an irreducible femoral epiplocele, that after the sac is laid open, nothing but omentum is found, although the symptoms of strangulation may have been well marked. It is possible that in some of these a small knuckle of intestine has been strangulated behind the rest, and reduced by taxis before the operation, without its having been noticed; the size is small, and it may be quite concealed; but there is no doubt that strangulated omentum can give rise to the same symptoms as intestine, though less marked and less acute. The pain is not so severe or the vomiting so constant; constipation is less complete and the constitutional symptoms are milder. The local distress is also inconsiderable, the tumour feeling harder, and permitting manipulation more freely than when it contains intestine. As time progresses, however, the symptoms become as severe as in other forms. The same thing has been known when only peritoneum was involved.

The time that elapses before gangrene or ulceration of the mucous membrane occurs is very variable. Erichsen mentions a case in which the vitality was destroyed in eight hours; in other instances the intestine may recover even after five or six days. It depends, to some extent, upon the kind and size of the hernia and the tightness of the constriction, but there is no doubt that a great deal of the injury inflicted on the bowel is due to ill-advised and violent taxis.

Symptoms of an almost identical character may be caused by other conditions of the bowel. Internal hernia and strangulation by bands or through apertures are, of course, really the same; the seat of strangulation differs, and that is all; but very acute symptoms may occur in volvulus, acute intussusception, stricture and impaction of fæces or gall-stones, sometimes with, sometimes without previous warning. The real cause of the symptoms is the effect, not upon the blood-vessels (though this forms a convenient standard to judge of the vitality of the tissues), but upon the nerves of the peritoneal covering; and this is borne out by many isolated facts. I have met with cases of external hernia in which all the symptoms of strangulation were well marked without the bowel being either very tightly gripped or deeply congested; and the same thing has occurred from the simple retention of the bowel in a colotomy wound (Davies-Colley), and from herniæ of the subperitoneal fat dragging upon the peritoneum.

The diagnosis of strangulation.—Inflamed and obstructed irreducible herniæ are occasionally attended by symptoms resembling those of strangulation; there is constipation with pain, and perhaps vomiting, but this never attains the persistence or the character of the sickness of strangulation; there is no collapse, and an impulse on coughing can always be detected.

Acute peritonitis is more difficult; the vomiting may be persistent and very offensive, the patient may be in a state of extreme collapse and the bowels absolutely confined. In such a case the diagnosis must rest chiefly upon the absence of relation between the sac and the peritonitis, and upon the physical character of the hernia itself.

A few cases are recorded in which the vomiting of pregnancy and that which sometimes attends the late descent of a testis have been mistaken for that of strangulation. In all cases of doubt an operation should be performed.

Treatment.—The strangulation must be relieved either by taxis or by operation with the least possible delay.

1. *Taxis.*—The method depends upon the anatomy of the part, but the principle is the same in all. The structures around the hernia must be relaxed as far as possible, the neck of the sac must be steadied with one hand, sometimes, as in the inguinal variety, pulling it slightly down so as to straighten it out, and then the gentlest pressure used, squeezing it a little from side to side, and kneading it carefully with a view of emptying the hernia of some of its contents, or of returning the piece of intestine that came down last. Intestine slips up with a sudden rush and the patient experiences complete relief at once: omentum does not disappear quite in the same way, but as it yields it leaves behind it a distinct sense of something gone.

Of all the aids to taxis there is only one, an anæsthetic, that can always be relied upon, and that one may only be used when, should taxis fail, everything is ready for immediate operation. It is manifestly unfair to the patient to expose him a second time, with a short interval, to the depressing influence of an anæsthetic, and to run the risk of making the vomiting and the other symptoms worse in the meantime. Morphia may be given to quiet a very restless patient and prevent exhaustion, but it is of no help in other ways, and great care must be taken that the symptoms of strangulation are not obscured by it without the constriction being relieved.

An ice-bag, or Leiter's coil with ice-cold water, is of some use if applied within a short time of the descent: the bulk of the mass is reduced, and occasionally, if taxis is tried then, it succeeds almost at once, but cold is not advisable for old people with feeble nutrition, or where the hernia has already been cut off from the circulation for some time for fear of accelerating gangrene. Over omentum it has much less power. A hot bath may be used in large inguinal herniæ if there is much spasm and the patient cannot leave off straining; but it must not be forgotten that a bath of the temperature of 100° F. or 102° F. kept up for half an hour may cause very great depression.

From time to time other aids are recommended for special cases. Inversion of the patient, for example, raising the pelvis well above the shoulders, so that the intestines gravitate towards the diaphragm, is highly spoken of in some cases of large inguinal hernia. Care must be taken to keep the hips well flexed if it is tried. Aspiration of the intestine is exceedingly risky, but the fluid in the sac may sometimes be drawn off with a trocar and cannula with advantage. Enemata should never be used, and purgatives are the worst things possible.

Taxis is more likely to succeed with an inguinal than with a femoral hernia: the constriction in the one is muscular, in the other mainly ligamentous; but the tension of the obliquus externus has an immense influence upon the size of the crural ring; if the finger is placed in the canal while a patient is straining or vomiting, Poupart's ligament descends upon it with immense force. In the same way taxis is more successful in acquired inguinal hernia than in the congenital form, but here the length and obliquity of the neck are additional reasons. Very small and very large herniæ and those which are tense and hard are more difficult of reduction, other things being equal, than those which are lax and moderate in size.

Accidents from taxis.—Taxis is responsible for a very large proportion of the fatal results of hernia. The bowel is intensely congested; its walls are rigid and almost solid with blood; it is prevented from returning by a constricting ring with an edge sometimes almost as sharp as a knife, and over which it bulges in all directions; the vitality of the tissues is seriously impaired; no fresh blood has passed through it for hours or even days; and while it is caught like this an attempt is made to force it through. Sometimes, by careful attention to position, and by using every endeavour to relax the tissues, the ring may be so widened that some of the blood in the walls or of the gas in the interior is squeezed out, and then the rest may follow; but if the congestion is severe and the walls rigid and solid, it is impossible for them to yield sufficiently, while, on the other hand, they bruise with the greatest ease. Even when the constricting band is divided and manipulation applied directly to the intestine, and to the proper end of the loop, not indiscriminately to the outside of the tumour, reduction is often very difficult; and I have heard of a case in which it was necessary, although the neck of the sac had been freely incised, to open the abdomen and make use of traction from the interior.

Bruising of the skin and cellular tissue, ecchymoses in the walls of the intestine or in the omentum, and hæmorrhages into the bowel or the sac, are common results of taxis, and often cause inflammation. Other consequences, not so frequently met with, are more dangerous: rents in the serous coat, for example, rupture of the bowel, bruising to such an extent that sloughing ensues, and injuries of the sac, which may lead to the serious mistake that the hernia has been reduced while the strangulation still persists. Of these last the two most common are *reduction en masse* and *rupture of the sac.* It is, however, only fair to say that in the majority of instances they have been the result of the patient's own violence.

In the true reduction *en masse* (fig. 361) the sac is separated from its surroundings, and, with its contents still unreduced, is pushed bodily into the subperitoneal space. It can only occur in tolerably recent herniæ, in which the sac is not adherent, and is most common in the direct inguinal form. But it may be imitated easily in femoral hernia if the sac is freely separated from the tissues around and an attempt made to reduce the contents without opening it: suddenly the whole may slip up through the crural ring into the abdomen.

The extent of the displacement is not so great in the other forms. In one (fig. 362), which appears to be more common in congenital inguinal hernia, the neck of the sac only is detached and forced in (carrying with it the strangulated portion of intestine), while the rest still protrudes in the inguinal canal; in another the sac is hardly detached at all, but the unreduced intestine is so pushed up the canal, sometimes into a kind of diverticulum lying between the peritoneum and the fascia transversalis, that reduction is complete, so far as external appearance is concerned (fig. 363). These diverticula may either be formed at the time by partial displacement of the sac, or they may be congenital, and then they frequently attain a very large size.

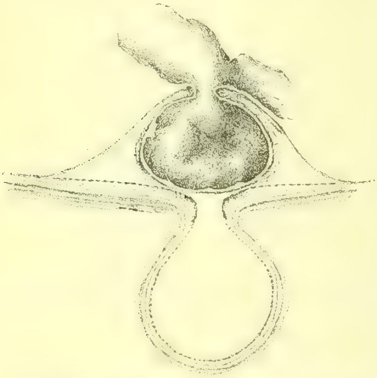
Fig. 361.—Reduction *en masse*, the sac entirely detached from its former site (as shown by the dotted line), and pushed into the subperitoneal tissue.

Rupture of the sac may be associated with this, or it may occur independently (fig. 364). The rent usually lies upon the posterior aspect, near the neck, and the intestine is gradually squeezed out through it into the subserous tissue.

The symptoms in all of these are very nearly the same. The contents of the sac do not slip back, they are gradually pushed to one side, leaving a certain degree of fulness over the neck; sometimes even a distinct tumour can be felt, dull on percussion, and very painful. In a few cases the mass has been felt repeatedly, returning into the abdomen with the least pressure and descending again as soon as the patient coughed or strained, but not disappearing altogether. The constitutional symptoms, so far from being relieved, are generally made a great deal worse by the injury inflicted upon the contents.

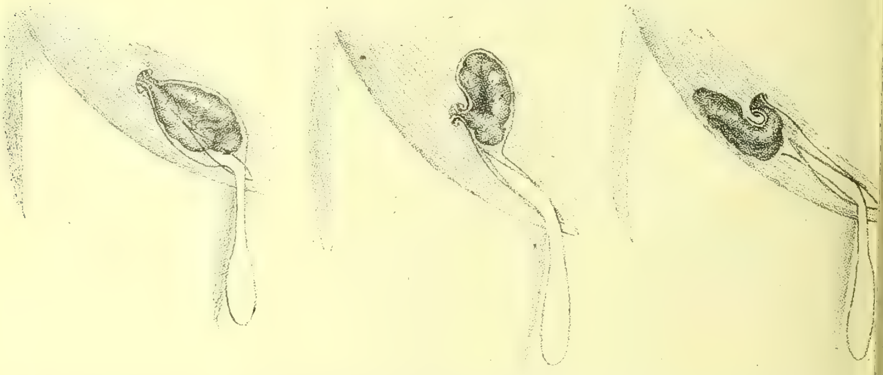
Three different varieties of imperfect reduction.

Fig. 362.—Reduction into the canal.

Fig. 363.—Intraparietal hernia.

Fig. 364.—Rupture of the sac

If any of these conditions is suspected, the sac must be exposed and opened at once. The incision may be made in the ordinary situation, or, if the tumour cannot be distinctly felt, in the middle line; all the ordinary apertures can be easily explored from this. The neck must then be divided freely, the bowel drawn out and examined, and the finger passed well up into the abdomen and down to the bottom of the sac, so as to make sure the condition is relieved.

In a few instances an omental sac, with the bowel strangulated in it, lies inside the peritoneal one, and it is possible that this may be reduced bodily, intestine and all, into the abdomen. If this occurs the symptoms persist in the same way, and the abdomen must be opened to ascertain the cause, as in other cases of internal hernia.

Taxis, even when successful, is sometimes followed by serious consequences. Of these the most common is *peritonitis*; the intestine is either inflamed at the time of reduction or becomes inflamed after being so long anæmic, and allows infective irritants to work their way into its walls. *Suppuration* and *sloughing* may set in, or *adhesions* form, binding down the bowel, or *stricture* may develop from the injury the coats have sustained. Sometimes a patient progresses favourably for three or four days and then sinks suddenly into a state of *collapse*, from the separation of a small gangrenous patch, and death may occur from *shock*, especially in the case of stout middle-aged women, whose circulation is already embarrassed. I have known this happen on several occasions in which, as an anæsthetic was not administered, nothing else could have been held responsible.

The length of time taxis may be applied before further measures are resorted to cannot be laid down in an absolute manner; it depends upon the size and kind of hernia; whether it is tense or lax; how long it has been down; whether any previous attempts have been made, and whether there are any signs of inflammation. If there is a small tense knuckle of intestine lying in the crural canal, without any impulse on coughing, and if it has just descended, a single trial may be made, and then an ice-bag laid on the swelling for four or five hours. If at the end of that time it appears unchanged, and does not yield at once, the patient should be placed under an anæsthetic and herniotomy performed. If the symptoms are very acute, indicating a severe degree of strangulation, as, for example, in congenital inguinal hernia in young adults, even this is not advisable; it is better, for the sake of the intestine, to give an anæsthetic, and if, when the muscles are relaxed, a very brief attempt does not succeed, operate at once. On the other hand, a large scrotal or umbilical hernia, the contents of which are soft and lax, consisting largely of omentum and without acute symptoms, may be manipulated with considerable freedom. If the skin over the hernia is red or tender; if the strangulation has lasted for two days acutely, or three under any circumstances; if the constitutional symptoms are severe; or if there is the least suspicion as to the condition of the intestine, taxis should not be employed at all.

The subsequent treatment, if the intestine has been strangulated, requires as much care as after an operation. A spica or a truss must be applied at once to prevent the descent of the rupture again; the patient must be placed in bed; no food allowed for twenty-four hours, and nothing but a little ice until the vomiting from the anæsthetic has ceased; and a hypodermic injection of morphia or some tincture of opium should be given to keep the intestine at rest for at least forty-eight hours.

Herniotomy or kelotomy.—If taxis fails, or it is not thought advisable to try it, the constriction must be divided.

The patient is placed under an anæsthetic, with the shoulders slightly raised and the knees flexed; and the skin shaved and thoroughly cleansed. The incision is over the neck of the sac; in inguinal hernia, over the external ring in the direction of the canal; in femoral, over the upper part of the tumour immediately below Poupart's ligament; and the tissues between the skin and the sac are divided layer by layer until the outer wall of the latter is reached.

In recent herniæ the sac is readily recognised. It has a bluish appearance, like a thin-walled cyst, and is covered with a layer of loose cellular tissue, devoid of fat; the vessels branch irregularly upon it, not running in a definite direction as on intestine; and, unless adherent, it can usually be thrown into folds and made to move over the subjacent structures by pinching it up with the fingers. In other cases the intestine, or the yellow fat of the omentum, can be seen through it, so that there is no doubt when it is reached. In old herniæ, however, over which a truss has been worn for years, the difficulty may be very great; the sac may be thick, dense, and fibrous, so that layer after layer is divided, each one apparently the last; or it may be so closely adherent to the structures around that its definition is impossible. Sometimes there is a cyst lying over it (generally a bursa) which may be opened by mistake; or, as in encysted or infantile hernia, there may be a definite peritoneal sac in front. The difficulty is especially serious when the sac is flaccid or empty, or surrounded by subserous fat; under these conditions, especially if it has been bruised by taxis, it may resemble congested omentum very closely. In other instances it does not contain any fluid, or the intestine is adherent to its inner surface over the front, so that it is in danger of being wounded; and, what is perhaps most serious of all, the sac may be partially or entirely wanting. In this case (which rarely happens except with the bladder and some portions of the colon), the hernia rapidly forms adhesions to the cellular tissue around, and, unless the muscular wall is recognised as it is approached, there is great danger of its being incised by mistake.

As soon as the sac is recognised, the neck must be exposed and the finger passed along it to ascertain the condition of the structures around. In some cases the stricture is altogether outside, and it is possible to divide it and effect reduction without anything further; the sac is not opened, and the operation consists merely in the division of a few tendinous or muscular fibres near the peritoneum. It is seldom possible, however, to do this, not in more than one-fifth of the cases, without running an unnecessary risk; in most it should never be attempted; and except in large scrotal or umbilical herniæ, with only subacute symptoms, it does not present any real advantage. Statistics prove nothing; the causes of death after herniotomy are taxis and delay, not the operation; it is the rarest thing possible to be able to trace the death to anything connected directly with this; and the cases which get well without opening the sac are precisely those in which, owing to the slight character of the symptoms, and the short duration of strangulation, the same result would have followed whether the sac were opened or not. The sole addition to the operation is an incision, made with every precaution, into an outlying part of the peritoneum, and carefully secured afterwards; on the other side is the immense advantage of being able to make certain of the condition of the contents.

In certain cases—large scrotal or umbilical herniæ with subacute symptoms—the attempt should be made, though in the latter it is not likely to succeed, owing to the extraordinary thinness of the walls; there is considerable danger in exposing a large quantity of intestine to cold or to the irritation of sponging; but it should never be thought of in small herniæ with acute symptoms; in those of a mixed character—entero-epiploceles, for example—as there might be an omental sac inside; or in any case in which, either from the condition of the skin, the history, or the constitutional signs, there is the slightest suspicion as to the state of the contents. If the operator has decided upon opening the sac, it should be done before dividing the constriction outside, for fear of a piece of intestine slipping back unawares.

Great care is needed while making the opening to avoid injury to the structures beneath. Part of the wall should be pinched up with the finger and thumb, so as to ensure its freedom from adhesions at that spot; and a small portion of the part so examined should be lifted up with dissecting-forceps, and opened with the knife on the flat, not cutting towards the interior. Fluid usually escapes at once. A director should then be introduced into the opening, and the sac freely divided up to the neck.

The subsequent proceedings depend upon the condition of the contents. If there is intestine and it is not seriously injured, the stricture is divided and the hernia returned at once. The incision is made in the same way, whether the seat of strangulation is outside the sac and is divided without opening the latter, or whether it lies in the neck; either the finger-nail, or a flat director, is insinuated under the margin of the band (and often it is so tight that this is a matter of considerable difficulty) and then a hernia-knife or a blunt-pointed bistoury, with the greater portion of the edge protected with strapping, is gently slipped under, and a very small incision made, without any cutting, simply by the pressure of the blade. As soon as this is done the difficulty disappears; the nail can be introduced more easily, and either the original wound enlarged, or, what is far to be preferred, two or three small ones made. Large incisions are not only more likely to injure adjacent structures, such as an abnormal artery, but weaken the abdominal wall and lead to a very intractable form of hernia. Care must be taken, when the sac is opened, that the intestines do not bulge upwards by the side of the director and get in the way of the knife; it is to prevent this that the hernia-director is especially broad.

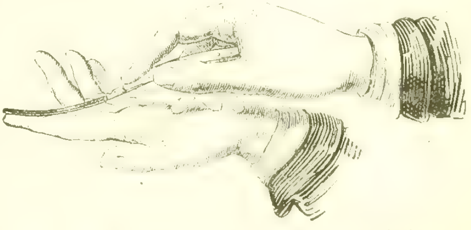

FIG. 365.—Method of dividing the constriction.

Occasionally, as already mentioned, there is some difficulty in reducing the intestine after the stricture has been divided, owing to the thickness and rigidity of the walls; but this may generally be overcome by applying taxis first to that end of the loop which was the last to descend. If this fails the intestine may be drawn slightly downwards; so long as reasonable care is used this may be done without fear, as the difficulty only occurs when the walls are unusually firm and solid. Aspiration of the bowel should not be attempted.

The condition of the intestine, whether it is fit to be returned into the abdomen or not, is determined by its consistence and colour. If it is soft and flabby, instead of firm and resilient, if there are ashy-grey or green spots upon it, or if the fluid is turbid and very offensive, it certainly is not. The difficulty is greatest where the intestine is almost black, and has lost its lustre, or is coated over here and there with flakes of lymph, or where, without any evidence of gangrene, it shows that it has been very tightly constricted; undoubtedly it stands a better chance of recovery inside the abdomen than if it is left in the sac; on the other hand, it is almost sure to set up a certain degree of peritonitis. Probably in this case it is best to return it, having first passed a catgut loop through the mesentery, so that it may be retained near the orifice. Possibly then, if sloughing does set in, adhesions may form around and fæcal extravasation be prevented.

Where the condition of the bowel is hopeless, it may either be left *in situ*, so that if the patient survives an artificial anus is formed, or it may be drawn down at each end until the whole of the gangrenous part is exposed, resected, sutured and returned. Which of these methods should be adopted depends upon the circumstances of each case; as a rule the patient is too feeble and exhausted to stand so prolonged an operation as enterectomy, and in femoral hernia, in which gangrene is most common, there is the serious objection that it practically entails division of Poupart's ligament. If the intestine is kept *in situ* the stricture should be interfered with as little as possible and the adhesions around the neck of the sac should not be touched: they are the only safeguard against a certainly fatal peritonitis. The wound should simply be left wide open; as the congestion and swelling subside the fæces find their way out through the upper orifice, and either a fæcal fistula or artificial anus is formed. Peritoneal rents in the coat of the bowel should be sewn up with catgut. A pin-hole perforation, if the surrounding part is healthy, may be treated in the same way.

Recent adhesions, unless the intestine is gangrenous, can be broken down with the fingers; older ones, if not too extensive, may be dissected off. In large irreducible herniæ, however, this is often impossible without endangering the bowel; and the rupture must be left *in situ* after the strangulation has been relieved. Later, when the wound has healed, the hernia may be fitted with a suitable truss.

Omentum must be thoroughly unravelled before anything is done with it; a small knuckle of intestine is often concealed behind it or in its substance, and may be easily overlooked. If it has only recently descended and is not congested, it may be returned; but if it is old and fibrous, or if it is already much injured, it should be secured with a clamp or forceps, cut off and ligatured bit by bit. As soon as it is certain that there is no risk of hæmorrhage, the end should be returned well within the peritoneal cavity; if it is left at the neck of the sac it does not act as a safeguard and plug the opening, but encourages the descent of a fresh portion by guiding it to the weakest spot, and, by leaving a band extending from the stomach to the groin, exposes the patient to the danger of internal strangulation.

The wound in the sac, after it is certain that all the contents are reduced, must be treated in the same way as every other wound of the peritoneum:

but, in addition to closing the orifice into the peritoneal cavity, an attempt should be made to strengthen that part of the wall so that the descent of another hernia at the same spot may be prevented.

When the intestine is gangrenous no attempt should be made to close the wound. In other cases it should be thoroughly cleansed, dried, and sutured with catgut, leaving a drain at the most dependent orifice. An absorbent dressing should then be carefully packed over it, so that the sides are pressed together, and a bandage applied over this. The tube should be removed the next day to clear it of any coagula, and, if need be, introduced again through the superficial part of the wound. Afterwards the dressings need not be disturbed until the wound is sound.

No food should be allowed for twenty-four hours, only a few fragments of ice to allay thirst; but if the patient is collapsed and the pulse failing, small quantities of brandy with soda water, a teaspoonful at a time, may be given at frequent intervals, until the skin is beginning to grow warm again. Meanwhile hot flannels and hot-water bottles should be placed all round, and every effort made to maintain the temperature. As soon as consciousness returns one-third of a grain of morphia should be given hypodermically to check peristalsis, and if the bowel was much injured, or if from the purgatives the patient has taken there is any fear of diarrhœa, small quantities of opium must be given two or three times a day until the danger is past. Milk, beef-tea, and arrowroot may be allowed after twenty-four hours, provided there is no sickness, and at the end of four or five days, if all goes well, a little custard or fish. If the bowels are left to themselves they are usually opened as soon as the patient begins to take solid food, at the end of five or six days; or, if not, an enema may be given. In many cases they remain confined for much longer periods without causing any distress.

Causes of death.—Death may be due to *shock* or to *exhaustion*, especially if, owing to the purgatives that are so often taken before advice is sought, diarrhœa begins as soon as the hernia is reduced. In most cases, however, the immediate cause is *peritonitis*; the symptoms that were present before the operation persisting, and growing worse, until collapse sets it. The intestine may have given way, causing fæcal extravasation; or the coats of the bowel, after being so long deprived of blood, may have become inflamed, as soon as the circulation was restored; or their vitality may have been so impaired that, without actual rupture, infective material can pass through them into the peritoneal cavity; or the contents of the sac may have been septic at the time. In any case the symptoms are characteristic.

The patient lies with the knees and hips flexed; the peculiar haggard and anxious aspect on the face continues and grows more distinct; there is not, when the effects of the anæsthetic wear off, that expression of relief significant of successful reduction; the tongue remains dry and brown; the pulse becomes more rapid and thready; the vomiting and constipation persist; the temperature may rise a few degrees, but very commonly, especially when there is gangrene, it either remains stationary or becomes subnormal; and the patient, overcome by septic poisoning, falls into a semi-unconscious state, resembling typhoid. Sometimes the abdomen is distended, firm, hard, and intensely painful when touched, while the respiration is confined to the upper part of the thorax; more frequently, although the surface is always tender, the collapse is so profound that there is no complaint of pain; and the abdomen, although its walls are tense from the contraction of the muscles, is empty rather than distended, and moves a little when the patient draws a deep breath. In such a case it is usually found *post mortem* that there are no flakes of lymph upon the serous membrane, and no adhesions; nothing but an intensely irritating, semi-purulent, and turbid fluid.

In other cases the symptoms of strangulation, the vomiting, collapse, and constipation persist, it may be for one or two days, before peritonitis sets in or the last stage is reached; and then it becomes a question whether the strangulation has really been relieved, or whether there may not be some further cause which has not yet been ascertained. Reduction *en masse* may have occurred, or the intestine may have been incompletely reduced; slight volvulus, owing to the elongation of the mesentery, may have followed; or there may be a second hernia, either external, at some other of the abdominal openings, or internal, through the omentum perhaps; or, finally, the strangulated portion of intestine, without becoming gangrenous or setting up peritonitis, may have been so injured that it is no longer capable of doing its work (*ileus paralyticus*). In such circumstances there should be no hesitation in exploring the abdomen; it is the only course left; if any tumour or hardness can be detected, as in reduction *en masse*, the incision should be made over it; if there is no guide, the abdomen should be opened in the middle line, the seat of the original operation examined first, then the other situations in which hernia commonly occurs, and if this does not reveal anything, the collapsed intestine, below the injured part, must be found and traced upwards until the cause is ascertained.

Care must be taken not to mistake the vomiting that arises from the anæsthetic for that which is due to the persistence of strangulation. As a rule, there is little difficulty, for even when it continues for more than a few hours, and is not checked by giving small fragments of ice to suck, or by warm applications to the abdomen, it is never offensive or fæcal in character, it does not come up in great gushes, and the retching is much more severe.

Sequelæ.—Strangulation of intestine may be followed by after-consequences of a more or less serious description.

Local peritonitis is very common, and is often preservative. The intestine, after reduction, has become inflamed, or may even have sloughed, and adhesions form around it to prevent the extravasation of fæces; but this may lead to serious results at a later period. The intestine may be tied down in a loop; or it may be dragged upon at one spot until it forms an angle in the interior, obstructing the passage of the contents; or the peritoneum may be so thickened that peristalsis is rendered difficult; and even stricture may result.

In other cases *stricture* is due to the injury sustained by the mucous membrane. It ulcerates opposite the sharp edge of the constricting band, especially in femoral hernia, and after reduction, when it cicatrises, it sometimes narrows the canal to a very serious extent.

Volvulus, or twisting of the intestine, causing very acute symptoms, sometimes happens, the regularity of the movements being broken and thrown out of order by the elongation of the mesentery and the formation of adhesions.

If gangrene sets in and the contents of the bowel are discharged externally, either an *artificial anus* or a *fæcal fistula* is formed, according to the extent of the slough. If it is the whole circumference of a loop, so that the two ends open on the surface side by side, it is said to be an *artificial anus* ; if, on the other hand, only one side gives way, so that the fæces in part find their way externally, in part follow the natural route, it is a *fæcal fistula.* In a few instances a communication has formed between two loops of the bowel, inside the abdomen—a *fistula bimucosa.*

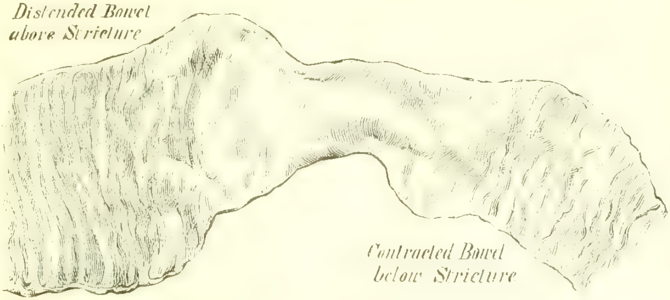
Distended Bowel above Stricture
Contracted Bowel below Stricture

FIG. 366.—Stricture of the small intestine after strangulated hernia.

SPECIAL HERNIÆ

INGUINAL HERNIA

Inguinal hernia protrudes through one or both abdominal rings. There are two classes : the external, oblique, or indirect, the neck of which lies outside the deep epigastric artery ; and the internal, or direct, the neck of which lies to the inner side.

1. *Oblique Inguinal Hernia*

In this the intestine enters the internal ring, passes in front of the deep epigastric artery, and lies in the inguinal canal, in front of the spermatic cord. If it does not emerge through the external ring it is called a *bubonocele* ; if it projects it is *complete*, and if it descends sufficiently far it is *scrotal* or *labial*, according to the sex.

The sac may be congenital or acquired ; in the former case the bowel lies in the tunica vaginalis, which has either not been closed or has been forced open again ; in the latter a new sac is formed out of the peritoneum covering the internal ring.

a. Congenital inguinal hernia.—The peritoneum which lines the lower part of the abdomen in the fœtus, and that which is attached to the gubernaculum testis, descend with the testis between the eighth and ninth months, the testis and peritoneum coming down together, or the pouch preceding the testis. This process of peritoneum is the tunica vaginalis ; at birth it very commonly communicates still with the general cavity, and it may continue to do so for a few months or even for the whole of life, though the opening may be so small as only to admit serum (congenital hydrocele). As a rule it becomes obliterated, first at the internal ring, then immediately above the testis, leaving an isolated sac in between, and finally this disappears. The right testis descends later than the left ; often it does not reach the scrotum until the ninth month ; and consequently the changes that take place about the inguinal canal, are later on the right side. For this reason, and because of the lower attachment of the mesentery on the right, congenital inguinal hernia on the left side, by itself, is very rare: it may, and very commonly does, occur on both; but if it is met with on one only it is almost sure to be the right.

Hernia into the tunica vaginalis is called congenital, because of the condition of its sac. Naturally it is frequently met with at, and shortly after, birth; but it may not occur until adult years; and the pouch may remain open for the whole of life without the intestine ever entering it.

There are two varieties of congenital hernia, depending upon the mode of closure of the canal:—

1. When the tunica vaginalis is open the whole way down, so that the intestine can descend as low as the testis and come into contact with it (fig. 367).

2. When the sac is closed above the testicle. In this case the hernia descends into the funicular portion of the tunica vaginalis only, and rests upon the top of the testicle without touching it (fig. 368). Occasionally the closure at this point is incomplete; there is a constriction, but nothing more, so that if a hernia descends and passes down to the bottom it assumes the shape of an hour-glass.

Congenital inguinal hernia is common in female children, the protrusion passing down in the canal of Nuck; and is sometimes met with in adults, constituting the ordinary form of labial hernia.

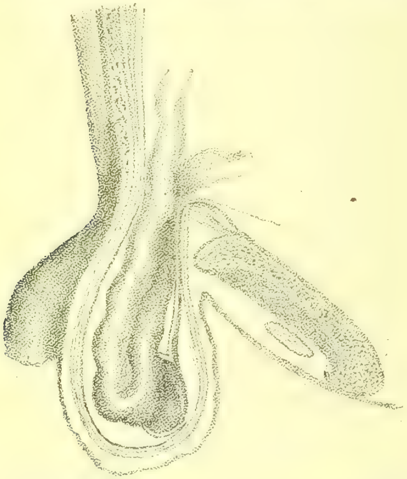

Fig. 367.—Congenital hernia into the tunica vaginalis testis. The intestine and testis in contact.

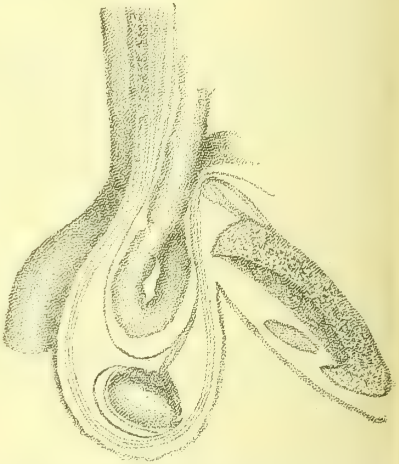

Fig. 368.—Congenital hernia into the funicular portion of the tunica vaginalis. The same diagram would answer equally well for an acquired hernia.

(*b*) *Acquired oblique inguinal hernia.*—This is rare before adult life and is much more common among men than women. It enters the internal ring, gradually pushing the peritoneum in front of it, forming a bubonocele first, and then becoming complete. Its progress, therefore, is gradual, while that of the congenital variety is rapid and sudden; in course of time it may attain a very large size, and by its weight drag one ring so near the other that the inguinal canal, as such, is destroyed, and the rupture appears to come directly out of the abdomen.

There are two varieties, one exceedingly rare; the other, the most common of all, depending upon the size and relation of the tunica vaginalis.

1. It occasionally happens that the tunica vaginalis is closed at the internal ring and nowhere else, so that there is a great pouch of peritoneum investing the testicle below, extending up the inguinal canal, and only shut off from the abdomen by a thin septum. If an oblique hernia develops under these conditions, a fresh sac is pushed down either behind this or into it (invaginating it), so that when the intestine is exposed by an incision from the front three layers of serous membrane are divided—the anterior and posterior walls of the tunica vaginalis and the anterior wall of the hernial sac. This is the *infantile hernia* of Hey (fig. 369). The encysted hernia of Astley Cooper is probably the same; the cicatricial septum which was supposed to stretch across the orifice of the canal having been shown by Lockwood to have no existence.

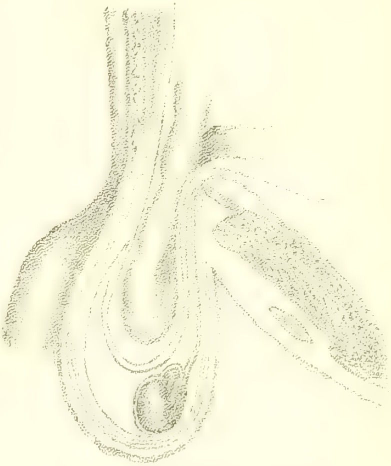

FIG. 369.—Infantile hernia.

2. In the other, the common form of acquired oblique hernia, the tunica vaginalis is in no relation with the peritoneal sac. A fresh one is formed, which generally descends in front of the spermatic cord, but occasionally in its substance, and the testicle is at first below, then below and behind the hernia, becoming more prominent as the sac grows tense.

2. *Direct Inguinal Hernia*

In this the protrusion usually takes place through the structures that lie immediately behind the external ring, the conjoined tendon and the triangular ligament being stretched or split; occasionally, however, the neck of the sac is higher up, on the outer side of the obliterated hypogastric artery, between it and the epigastric, and the hernia lies, for a very short part of its course, in the canal. The coverings are the same as in the oblique form, except that the conjoined tendon (when it is not split) takes the place of the cremasteric fascia. The cord, however, lies more to the outer side of the sac; the hernia is usually smaller and more globular, and, after it is reduced, the finger seems to pass straight into the abdominal cavity.

Diagnosis.—Inguinal hernia must be distinguished from :—

1. Swellings in front of the inguinal canal, such as *enlarged glands*. These may be recognised by their relation to the external ring. If the tip of the forefinger is placed at the bottom of the scrotum and pushed upwards, invaginating the skin, behind the spermatic cord, it rests first upon the front of the pubes, then on the ring itself; and the swelling, if it is a gland, can be lifted away from the front of the canal.

2. Tumours below the inguinal canal. Of these the most important is *femoral hernia*, which often curls up over Poupart's ligament; the neck of an inguinal hernia, however, if the finger is placed on the spine of the pubes, always lies internal to it; that of a femoral one always external.

3. *Hydrocele*, *hæmatocele*, and *tumours of the testicle* are distinguished by the line of separation between the scrotal swelling and the external ring. The only exception is that form of hydrocele which occurs in infants and young adults, in which the tunica vaginalis is closed only at the internal ring, and the swelling extends through the external one into the canal. The swelling, however, begins in the scrotum and the tumour is translucent.

4. Enlargements in the canal are the most difficult, and if there is the least doubt, and symptoms of strangulation are present, an operation should be performed at once. *Fatty tumour* or *sarcoma of the cord*, *encysted hydrocele*, and the *testis descending late*, are the most common, but though their position in the inguinal canal can be altered to some slight extent, none of them can be reduced in the same way as a hernia. It is said that *varicocele* may be mistaken for hernia, although the difference in the consistence and feeling, and the way in which a varicocele disappears when the patient lies down and reappears when he stands up, no matter what pressure is made upon the ring, must make such a thing almost impossible.

Direct hernia is distinguished from indirect or oblique by its globular shape and the absence of fulness along the canal. In old oblique hernia the internal ring may be dragged so far to the inner side that the rupture appears to come straight out from the abdomen; but this never happens unless the size is very considerable. It is sometimes possible, when the opening has been stretched by long-continued traction, to feel the deep epigastric artery.

An oblique inguinal hernia is probably congenital if it occurs before puberty (though it is not confined to this period of life), or if it made its appearance suddenly; in the acquired form it takes some time, often months, to stretch the tissues sufficiently. The relation to the testis is not a certain guide; if the intestine is plainly in contact with it, and envelops it, the hernia is probably congenital; but the converse is not true.

The neck of a congenital inguinal hernia is never shortened in the same way as that of an acquired one; and partly from this, partly from the suddenness of its occurrence, it is very much more likely to be strangulated.

Treatment. 1. *Taxis.*—The shoulders and the pelvis should be slightly raised to relax the abdominal muscles, the thigh flexed and adducted, and the patient directed to breathe as quietly as possible, and avoid straining. The fingers of one hand grasp the neck of the sac and pull it slightly downwards; the other manipulates the hernia. In direct and old acquired ones the pressure is applied from before backwards; in those that are recent or congenital it follows the course of the canal.

If the hernia is reduced, it must be kept from descending again either by means of a pad and a spica bandage (put on while the limb is flexed) as a temporary measure; or a truss, the pad of which lies upon the internal or external ring, according to the variety, and presses either directly backwards or backwards and upwards, according to the shape of the abdomen. It must not touch the pubic spine or rest upon the cord; and the spring must be so adjusted that while it does not press injuriously when the patient is at rest, it is sufficiently strong to retain the hernia even when he strains downwards with the hips partially flexed. In the congenital variety, if the hernia is prevented from descending, the neck of the sac usually closes of its own accord; and, with sufficient care, a permanent cure may be looked forward to in most cases under ten years of age. Owing to the fact that the mesentery does not grow in proportion to the body, the tendency for the rupture to descend diminishes rapidly; but if it comes down once all the good is undone. When the hernia is irreducible but not strangulated, either the rupture must be supported and prevented from increasing by means of a bag truss, or, if the patient's age and constitution allow it, and the hernia is not too large or too extensively adherent, an attempt may be made to return it and effect a radical cure.

When there is an undescended testicle the treatment depends upon the situation and condition of the organ and the age of the patient. As a rule, if the testis does not descend within a few months of birth, it remains quiescent until puberty. Then it may come down, but whether it does, or whether it remains in the inguinal canal, hernia is an exceedingly common complication and strangulation not unfrequent. If the testis can be pushed either back into the abdomen or out through the ring, a truss can usually be worn, and ultimately a cure may result; but if it remains in the inguinal canal it rarely happens, even with water or air pads, that it is able to accommodate itself sufficiently well. Under these circumstances it is usually advisable to perform some radical operation, and either transplant the testicle, or if it is small and shrunken, or extensively adherent, remove it altogether and stitch up the pillars of the ring. The same treatment should be adopted when a retained testis is met with in an operation for strangulated hernia.

If strangulation is acute, particularly if the hernia is congenital, the patient should be placed under an anæsthetic, and unless taxis succeeds at once an operation performed. If, on the other hand, the rupture has been down many times before, and the symptoms are not severe, an ice-bag or a hot bath may be tried and a delay of a few hours sanctioned.

2. *Herniotomy.*—An incision two inches in length is made over the long axis of the tumour, opposite the external ring, and the skin, superficial fascia, and superficial external pudic vessels divided (fig. 370). The margins of the ring are then defined. In some cases the sac is deeply grooved by the fibres of the external oblique, and if these are divided the constriction is relieved without anything further. More frequently there is only a shallow mark, no real constriction, and layer after layer of tissue is divided on a director until the sac is exposed. This is opened with proper precautions, the forefinger passed along the anterior surface of the protrusion as far as the internal ring, and the seat of stricture felt. The finger-nail is slipped beneath it and a curved blunt-pointed hernia-knife passed along the finger with the blade laid flat, until it can be guided beneath the constricting band. The edge is then turned upwards and a very small incision made parallel to the linea alba, so that, whether the hernia is internal or external, the deep epigastric artery may not be wounded.

The contents of the hernia must then be dealt with, the sac removed, ligatured or sewn into a pad according to circumstances, and the pillars of the ring sutured as in the operation for the radical cure.

Radical Cure

By the radical cure of hernia is meant an operation that will not only permanently prevent the hernia descending, but will relieve the patient of the inconvenience of a truss.

In certain cases it is admitted that some measure of this kind is either necessary or very desirable. After herniotomy, for example, if the bowel is not gangrenous or the patient exhausted, an attempt should always be made to close the opening. In other instances there are special reasons why a truss is not desirable; there may be, for example, an undescended testis fixed in the inguinal canal; or a large mass of unreduced omentum over which a pad will not fit comfortably; or the hernia may be of such a nature that no truss is able to retain it; or the patient may be too unintelligent or too careless, or he may be placed in such circumstances that were anything to happen to his instrument it could not be renewed. In such as these there is no doubt — the question is, how far an operation is advisable as an alternative to a truss, and whether it can be relied upon to effect a permanent cure without too much risk.

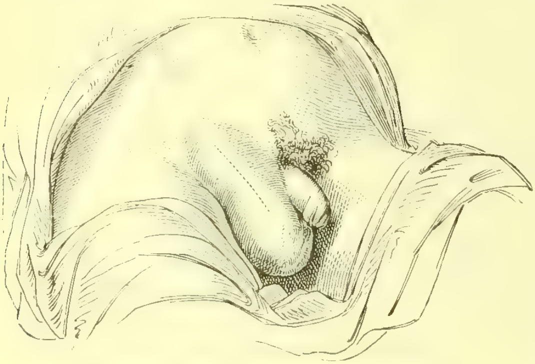

FIG. 370.—Incision in inguinal hernia.

If the cases are properly selected it is certainly effectual. In children, for example, in whom, from carelessness or other reasons, a truss has failed to procure the closure of the canal, in young adults with a recent hernia, and in older men of sound constitution and wiry frame, in whom the inguinal canal has not yet been distorted, a cure is practically certain, and the risk is so small that it is a matter of question whether it is really greater than that attendant on the wearing of a truss. On the other side, the presence of a hernia disqualifies from entering the Services, renders a man at the most active period of his life unfit for many kinds of employment, and exercises a definite restraint in everything he does.

If, however, the patient has already reached middle life, is comfortable with a truss, and has lost the impulsive activity of youth; or if he is old for his years; or if the abdominal walls are thickened and fat, or shaped so as to suggest prolapse of the mesentery; or if there is the least suspicion as regards his general health—the cure might be effectual; but the risk is too great, provided, that is to say, the rupture can be kept up with a truss. When this cannot be done the question rests on entirely different grounds.

(*a*) *Subcutaneous Operations*

These, which met with very fair success in the hands of those who devised them, have given way almost entirely to the open ones. The two best were Wood's and Spanton's.

In the former the sac is invaginated and a suture passed first through the inner boundary of the canal, as high up as possible, then through the outer, leaving a loop projecting through the skin above the external ring, and finally under the sac between it and the spermatic cord. The projecting ends are then fastened together, pulled by means of the loop as far up as possible, in order to complete the invagination, and twisted round each other. At the end of eight or ten days, when sufficient lymph has been thrown out, they are partially untwisted and withdrawn. A horse-shoe pad must be worn for some months; afterwards it can generally be dispensed with. In a successful case the inner ring is closed flush with the peritoneum, the conjoined tendon drawn out and fixed behind the outer pillar, close upon the invaginated sac, and the pillars of the superficial ring drawn together; it cannot, however, be said that the valve-like action of the canal is restored.

In Spanton's an instrument shaped like a corkscrew with a wide spiral is made to perforate the invaginated sac and the walls of the canal for the whole of its length, piercing the sides alternately. It may either be left *in situ* for a week or ten days, or when the point is exposed it may be threaded with a ligature and twisted out again. The two ends of the ligature are fastened over a metal plate, which is placed upon the inguinal canal until the parts are consolidated. According to Spanton, this is chiefly suited to the congenital inguinal hernia of children.

Injection.—The idea of plugging the canal with lymph by means of injection has recently been revived, but not with great success. It may be done either through an incision or subcutaneously with an instrument devised by Keetley. The scrotum is invaginated with the forefinger, the sac pushed well up and the needle of the syringe passed through the skin from above and outside the internal ring down towards the pubes, until it meets the finger in the canal; when its position is assured the finger is withdrawn and the fluid injected. Absolute alcohol (five minims) has been tried without confining the patient to bed, but the injection had to be repeated many times. Glycerine and tannic acid produce more reaction; the tissues around swell up, the groin becomes full and tender, and a good deal of lymph is effused. But although the method may be safe it is not certain. It may be impossible to injure the hernia with the needle pointing towards the pubes, but the injection may be thrown into the spermatic cord, or some of it may escape into the tissues outside the canal, and the sac is not dealt with in any way. Some of these objections are overcome by using sutures as well, but in this case the open method throughout is to be preferred.

(*b*) *The Open Method*

In this the sac and the external ring are thoroughly exposed. As compared with the former it is more precise and certain in its results, quite as safe so far as the danger to life is concerned, and does not expose the cord to so much risk. It is, of course, the only plan admissible when the hernia is irreducible.

The operation consists of two distinct steps, one dealing with the sac, the other with the canal. The patient must be carefully prepared and the parts shaved and thoroughly cleansed; the incision through the skin lies over the external ring, or may with advantage be placed a little higher.

The sac.—The first step is to isolate this thoroughly. In congenital hernia, if the cord causes any difficulty, the plan suggested by McEwen may be followed. The sac is opened and two longitudinal incisions are made in it, one on either side of the cord, parallel to it, so that this, with the strip that adheres, is left undisturbed. If the pouch is open right down to the testicle, the lower end must be separated from the rest to form a tunica vaginalis; but it is not necessary to sew this up; the walls collapse and adhere to each other, or to the testis, almost at once.

When the sac is separated it may be either cut off, the neck being tied and fixed by sutures at the internal ring, invaginated, twisted, or sewn up into a pad and pushed into the subserous space, so that it no longer lies in the canal at all. Of these the two last are to be preferred; in both the separation of the sac must be complete and the peritoneum continuous with it must be detached for at least half an inch inside the margin of the internal ring.

(*a*) *Torsion* (Ball).—The sac is first examined to make sure that it is empty. The neck is grasped with a pair of broad catch-forceps, and, while the finger detaches the tissues around, is twisted until it is felt to be quite tight and that any further torsion would tear it. A stout catgut ligature is then placed round the twisted sac as high as possible, tied tightly and the ends cut off short. The effect of this is to throw the peritoneum around the opening into a number of spiral folds, extending over such a distance that in two cases the opposite ring was narrowed sufficiently to prevent the descent of a hernia. Sutures are passed afterwards through the pillars of the ring and the twisted neck, so as to press the latter towards the abdominal cavity and prevent anything like a funnel-shaped depression on the peritoneal surface. No ill result has ever been recorded after this, but it must not be forgotten that in some cases strangulation of the parietal peritoneum (as in subperitoneal fatty herniæ) has given rise to symptoms of the same character, although of less intensity, as strangulated intestine.

(*b*) *Folding* (McEwen).—In this the sac is thoroughly freed, not only at the fundus and neck, but for half an inch farther inside the constricting ring; it is then drawn down, examined to see that it is free, and a stout catgut suture fastened to its base. This is threaded on a needle and passed through the serous layers from side to side at very short intervals, working towards the neck, so that when it is drawn upwards the sac is thrown into a series of short folds closely pressed together. The pad thus formed is pushed inside the ring and fixed there by passing the suture through the muscles on the front wall of the abdomen from within outwards. In this way, a solid block of invaginated sac is placed over the ring —not in the canal—projecting into the peritoneal cavity (fig. 371), so that when the coils of the intestine are forced downwards they are thrown off on to either side. Owing to the way in which the margins of the ring are refreshed by detaching the peritoneum, the pad very soon becomes adherent at its new site.

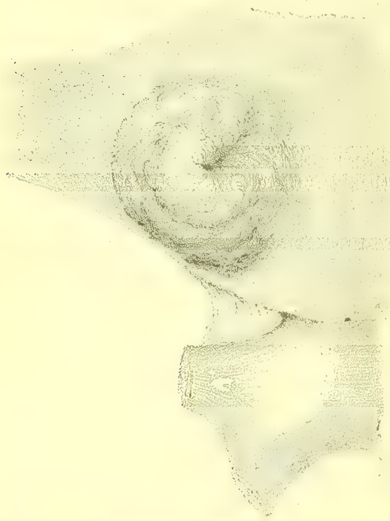

FIG. 371.—McEwen's pad, as seen from the inside.

The canal.—The second step is to suture this and restore its valvular shape (fig. 372).

Where it has not been shortened by the traction of the hernia the simplest method is to pass a Liston's needle, threaded with silk or well-seasoned catgut, up the canal along the finger until it perforates the inner boundary of the ring. It is then unthreaded, withdrawn (leaving the suture), threaded again with the other end, and passed through the outer boundary at the opposite point. Four to seven sutures, according to the length of the canal, may be passed in this way, each perforating all the structures that form its outer and inner walls, and leaving beneath them a small space along the floor for the spermatic cord. If the neck of the sac has been tied or twisted, the first suture may be passed through it to hold it well up in the abdomen; but, in any case, it must perforate the boundaries of the inner ring as high as possible. This one should be secured as soon as it is passed, the others should all be inserted before one is tied, in order that the effect on the spermatic cord may be noted when they are all lifted up together.

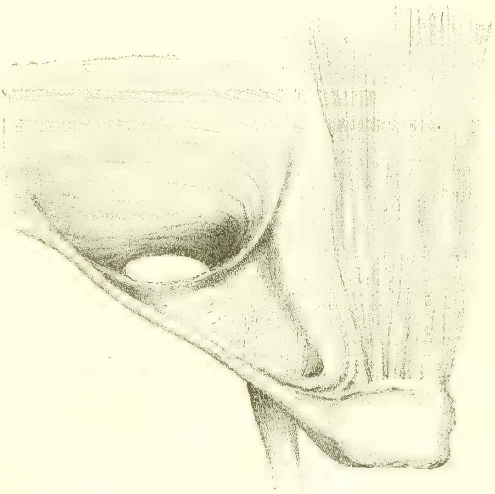

Fig. 372.—The canal seen from inside, showing its valvular shape. (After Astley Cooper.)

When the canal is shortened McEwen's plan is preferable; merely stitching the opposite walls together scarcely forms any protection. The finger is introduced into the canal, after the pad formed out of the sac has been placed in position, and the deep epigastric artery and the inner border of the ring carefully defined. A hernia-needle with a sharp lateral curve at the end (right or left according to the side) is passed up the canal through the conjoined tendon (in and out) into the canal again, and threaded there so that when it is withdrawn, a loop of catgut is left on the deep surface of the tendon with the two ends free in the canal (fig. 373). These are dealt with separately. The upper is threaded on a needle and passed through the internal oblique muscle, and the aponeurosis of the external oblique from within the canal towards the surface, on a level corresponding to the upper end of the loop. The lower is treated in the same way, but is only passed through Poupart's ligament.

By this a double suture is formed across the internal ring, drawing its inner margin outwards towards the under surface of Poupart's ligament. The two free ends emerge on the surface of the external oblique, the loop lies on the abdominal side of the conjoined tendon; when the ends are tied together this is drawn directly outwards and downwards until it lies beneath the margin of the outer pillar and closes the ring like a valve.

A second double suture may be passed in the same way lower down in the canal, or, now that the valve is restored, the walls may be sewn together as in the former plan.

In some cases, operating upon this plan, I have found very great difficulty in securing anything like a conjoined tendon. In one, at least, there was nothing of the kind attached to the ileopectineal line, and probably this was the cause of the hernia.

The sutures should either be of well-seasoned catgut or silk; their object s to secure the position of the sac and the walls of the canal until a sufficient amount of lymph has been thrown out to consolidate them and glue them all together. Wire is unnecessary ; it cannot hold fibrous tissues together if there is any strain, and although, if the wound heals by the first intention, it becomes buried and disappears, it is always liable, years afterwards, like any other foreign body embedded in soft parts, to set up a certain amount of irritation, and gradually ulcerate its way out. In a successful case the tissues become hard and dense after the operation, and not unfrequently after the stitches have been absorbed, or, at least, have lost all hold on the parts, the walls of the canal become more and more closely approximated by the gradual contraction of the lymph that has been poured out. The sutures should never be drawn too tight for fear of their cutting out too soon, and care should always be taken that a sufficient amount of space is left for the spermatic cord.

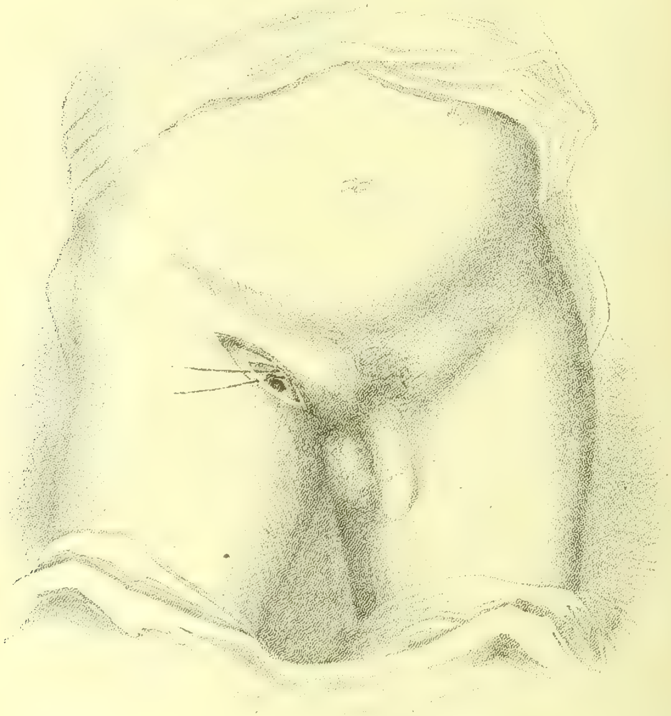

Fig. 373.—McEwen's sutures to draw the conjoined tendon down to Poupart's ligament.

The treatment of the wound is very simple. It is well sponged out wit an antiseptic and dried ; the edges of the skin are brought together with a continuous catgut suture, and sprinkled over with iodoform ; and the groi is carefully and evenly packed with an absorbent dressing, so as to ensur equable pressure and perfect rest. If there has been much handling of th parts a drainage-tube is inserted, and the dressing is removed the next da to make sure that it is not clogged ; afterwards it is enough if it is place just between the edges of the wound. At the end of a week or ten day healing is generally perfect, and the tube, with the portion of the sutures tha has not been absorbed, is found lying upon the skin.

A spring truss should not be worn after the operation, as its pressure tends to cause premature absorption of the lymph; but the abdominal wall requires a certain amount of support for some months. In infants this may be managed with a skein of Berlin wool as already described; but for children and adults the form of appliance known as Harrison's truss answers best. It consists of a well-fitting pelvic band, and two short thigh-pieces made of linen, like a pair of very short drawers, fitting tightly and fastened with laces. A perinæal band prevents its ascending, and it may in addition be furnished with a scrotal bag, and with braces passing over the shoulders.

Femoral Hernia

Hernia into the crural canal, the small conical space with base upwards which is bounded in front by Poupart's ligament, the deep crural arch, and the falciform edge of the fascia lata; on the inner side by Gimbernat's ligament; on the outer by the femoral vein; and behind by the bone (fig. 374). In very rare instances the rupture protrudes externally to the vessels.

Femoral hernia rarely occurs under puberty, and is more common among women than among men. The sac is always acquired, and the tissues that lie in the canal are pushed lown by it and compressed so as to form a ascia propria. At the aphenous opening it omes into contact with he cribriform fascia, nd as soon as this gives ay the hernia curls up- ards upon itself until it rojects over Poupart's gament, and lies upon ie abdomen. The size rarely very large, al- iough moderate ones e not uncommon. The contents may be intestine only, but in a large pro- rtion of instances there is as well a mass of irreducible and adherent omen- m. In one or two cases the cæcum has been found inside.

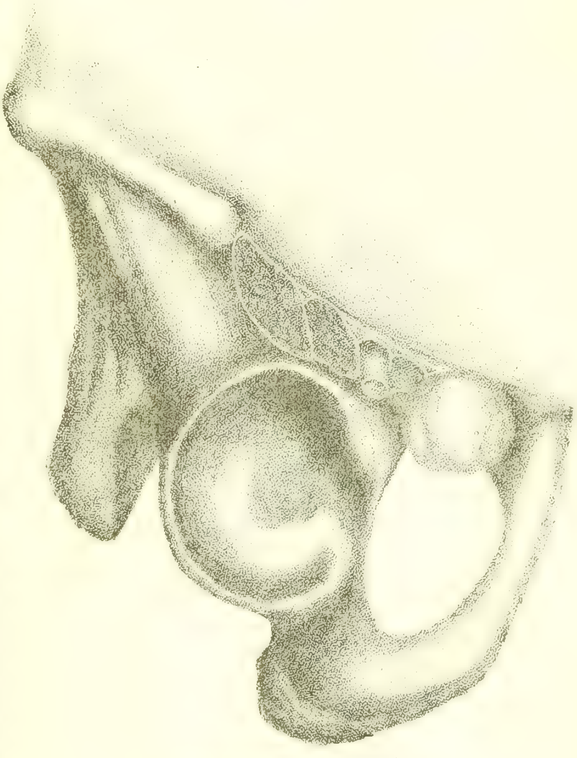

Fig. 374.—Femoral hernia.

Femoral hernia either forms a small tense rounded tumour immediatel low Poupart's ligament, or a larger softer swelling of irregular shape, trace- le to a neck in the crural canal. So long as it is not strangulated there an impulse on coughing; and if the portion of intestine is not too small

(Littre's hernia usually takes place here) or too much covered in with omentum, it may be resonant on percussion.

Diagnosis. *Inguinal hernia.*—Sometimes, especially in women, a fold which may be mistaken for the fold of the groin extends across the thigh lower down; but the spine of the pubes can always be felt, and the neck of a femoral hernia always lies below it and to the outer side.

Psoas abscess.—The swelling in this case lies beneath the vessels as well as to their inner side; there is a fulness in the iliac fossa above; fluctuation can usually be detected, and gradual reduction takes place when pressure is made upon the swelling.

Varix of the femoral vein occasionally resembles femoral hernia; there may be an impulse on coughing; but if the finger is placed on Poupart's ligament after the swelling has been reduced the vein is filled from below.

Enlarged lymphatic glands often present great difficulty, especially when there is only one and it is not elongated transversely; but it never possesses a neck like that in hernia.

Fatty growths in the canal, *cysts*, *hydrocele of the sac*, and a *thickened empty sac* often cannot be diagnosed. In such circumstances, if symptoms of strangulation are present, an exploratory operation should be performed.

Treatment. 1. *Reducible hernia.*—This should be supported by a truss the pad of which presses a little upwards as well as backwards, hooking under Poupart's ligament, and is bevelled off on the outer side so as not to compress the femoral vein.

2. *Irreducible but not strangulated.* If there is only a small amount of omentum (the common form) a pad may be moulded over the protrusion to prevent its increasing; or an attempt may be made to effect reduction by taxis after the prolonged application of ice combined with scanty diet and iodide of potash; but, especially in young women, it is advisable to have the sac opened, the omentum removed, and a radical cure performed. On the one hand there is the exceedingly slight risk of the operation; on the other there is the existence of an omental band passing down from the stomach to the groin, exposing the patient to the danger of internal strangulation, and forming a kind of inclined plane which guides the intestine infallibly to the weakest spot in the wall. In most of the cases in which operation is required a small knuckle of intestine is caught and concealed behind irreducible omentum.

If Gimbernat's ligament is too freely incised, the hernia that follows is either irreducible, or, if it can be reduced, cannot be retained in position. In such cases a firmly-made thigh-belt, laced up, with a triangular pad to fit in Scarpa's triangle, affords more relief than anything else. It should eithe be attached to a truss or provided with a pelvic band of its own.

3. *Strangulated.*—In femoral hernia the symptoms are generally acute and taxis has little chance of succeeding, owing to the unyielding characte of the edges of the ring. If a portion of intestine has only just descended an ice-bag may be tried for a short time in the hope of reducing its bulk; bu if it is small and tense, and is down for the first time, or if there is an ol epiplocele, it is better to give the patient an anæsthetic, and if taxis does no succeed at once, operate. In the one case, if the least pressure is used, th edge of Gimbernat's ligament cuts into the congested bowel; in the other owing to the mass of omentum in front, the pressure is too diffused to ac with any certainty. If the symptoms of strangulation have lasted acutel

for more than two days, or if there is a history of many attempts at taxis, especially by the patient himself, the operation should be performed at once.

In applying taxis the position of the patient is the same as for inguinal hernia, the thigh flexed, adducted, and rotated inwards. The direction of the pressure is upwards and backwards, the tumour, if it has spread over Poupart's ligament, being drawn downwards. The neck of the sac is steadied with one hand, the utmost gentleness being used, and softly squeezed from side to side, while the other draws the rupture down and then quietly presses it up again.

The incision is vertical immediately over the neck, with its upper end on Poupart's ligament. The layers divided vary in each case, and often it is thought that the sac is exposed when the fascia propria is reached. The difference is plain at once if they are traced up to the neck; the one comes from the abdomen, the other does not. Hey's ligament, the curled-in edge of the falciform process attached to the iliopectineal line, is the first tense band divided, and sometimes then the hernia can be reduced. More often the deep crural arch and the lower fibres of Gimbernat's ligament, where it is separating from Poupart's, must be cut as well. If there is no reason for opening the sac, the finger-nail is slipped beneath them, and the end of a probe-pointed hernia-knife gently insinuated and slowly turned round, so as to make a small incision upwards and slightly inwards. If this fails, or if it is not thought advisable to try it, the sac is opened with the usual precautions and an incision made from the inside in the same direction.

The incision should be made very slowly by the pressure of the knife, and should be as short as possible; if more space is required it is better to make a second than to divide Gimbernat's ligament more freely, as this is usually followed by a most intractable form of hernia. Moreover, in a small proportion of cases (about 1 per cent.), the obturator artery pursues an abnormal course, coming off from the deep epigastric and winding round the upper border and inner side of the crural ring. If, as it usually does, it runs down between the hernia and the vessels it is not likely to be hurt; but if it loops round it may easily be divided, as it lies actually on the sac. For this reason the finger should be used in preference to a director, as the pulsation can sometimes be felt. Injury to the vessel may be avoided by using a blunt hernia-knife; the fibrous tissue is so tense that anything will divide it, while the artery is simply pushed away. If it should be hurt an attempt must be made to find the ends and ligature them or secure them with clamp-forceps, but without dividing Poupart's ligament; an incision should be made above it, as for ligature of the external iliac, and a careful dissection carried down until the bleeding points are exposed. In one case the lower end of the artery was drawn right into the obturator foramen. Free hæmorrhage may occur from the division of a small vein, but this stops of itself.

The contents of the sac must be dealt with according to the ordinary rules, but especial care is required in femoral hernia, as the constriction may cause ulceration, and even sloughing, of the mucous membrane without evidence of much congestion. Moreover, a small knuckle of intestine is sometimes concealed behind, and even in the interior of a mass of irreducible omentum.

The sac, when it has been emptied, should be detached thoroughly from the tissues around, and sewn up into a pad after McEwen's plan. Afterwards a suture may be passed through the boundaries of the ring in the way devised by Wood for the radical cure; a Liston's needle is passed through the pubic portion of the fascia lata, entering about an inch below and emerging close to the pectineal line, and then through Poupart's ligament. Catgut, silk, or wire may be used, as in the inguinal operation, and two, or at the most three, sutures inserted between Gimbernat's ligament and the femoral vein.

Umbilical Hernia

This may be congenital, or it may occur during infancy, or later, during adult life.

(*a*) The congenital form of umbilical hernia is due to the visceral plates failing to meet in the middle line, and allowing some portion of the intestine, and, in rare cases, the greater part of the abdominal contents, to protrude. Owing to the method of its development the cæcum is often found in it.

A sac is present in most instances, formed from the peritoneum, and extending among the tissues of the cord. It may be so thin that the nature of the contents can be seen at once, or it may be fairly thick. Occasionally it is wanting, even when the protrusion is small; in cases of great deformity it is naturally never developed. Strangulation may occur at the neck.

Reduction and ligature of the sac at its neck should be performed immediately after birth; if the protrusion is left the delicate tissues dry up and become adherent to the bowel. In cases of strangulation, or where the contents have formed adhesions to the wall, or are irreducible for other reasons, the sac must be opened. If reduction is successful, the edges of the ring should be brought together with a catgut suture.

(*b*) The umbilical hernia which is so common in infants is due to the stretching of the cicatrix shortly after birth. It never appears to lead to strangulation, and it is usually cured rapidly by the contraction of the orifice, if the rupture is prevented from escaping. Tight abdominal belts with button-shaped projections to fit into the opening are most injurious; the pad should either be flat (a penny sewn up in wash leather forms a very convenient one) or dispensed with altogether, the skin being merely rolled up into two folds, one on either side, and held together with strapping. In the case of a boy, four years of age, in whom the protrusion still persisted, I laid open the sac (which was very much thickened from the constant irritation of trusses), ligatured the neck and sewed up the opening with catgut. Wood has recommended lacing the orifice round with a suture.

(*c*) The form that occurs in adult life protrudes through the linea alba close to the umbilicus, occasionally in more places than one, so that two herniæ lie in the same tumour, separated at their necks by a tense band of fibrous tissue. It is usually met with in women who have had large families, and it may attain an enormous size, hanging down like a pendulous tumour filled with omentum, small intestine, or colon.

This hernia is frequently irreducible, and when it attains any size is especially liable to become obstructed and inflamed. Strangulation, when it occurs, is usually a sequel of obstruction: the tumour is allowed to hang down over the sharp edge of the ring, the veins are compressed, congestion sets in, the orifice becomes blocked with the swollen mass, and at length the circulation is stopped.

When the hernia is reducible it must be retained in position by a suitable belt; if this is impossible, it should be well supported, especially from beneath, and, as far as can be, prevented from increasing. Strangulation is often very insidious. The hernia has been irreducible for some time and is perhaps obstructed. At first there is only discomfort or uneasiness; then vomiting begins, and soon the constitutional signs of strangulation set in definitely. Taxis may succeed; but, owing to the way in which the strangulated loop is shielded by the rest, it often fails. In this case an incision must be made over the upper part of the tumour (Wood prefers the lower), and the neighbouring abdominal wall, in the middle line, and the skin carefully divided over the margin of the orifice. The sac is excessively thin, and the tissues are generally matted together from constant irritation; but an attempt should always be made to relieve the constriction without opening the peritoneum. If it cannot be done, either a small incision must be made through the fibrous ring, from the inside of the sac at one or two points, and the strangulated loop reduced, the rest being left as it was before, or the sac may be laid freely open, the contents unravelled and released from the omentum, which is spread over and among them, and the operation completed as in abdominal section, excising the redundant portion. Which of the two should be performed must be determined by the circumstances of each case; the latter requires the greatest care and may be exceedingly tedious and prolonged, but the results do not seem to be more unfavourable.

In one case, in which the walls of the abdomen were enormously thickened from the deposit of fat, I made an incision in the linea alba below the umbilicus, where, owing to the pressure of the tumour, the tissues were not quite so thick as in other parts, dilated the stricture from the inside, and withdrew the strangulated loop. The immediate result was successful, but the patient died some weeks later from bronchitis and prolonged suppuration in the abdominal wall.

Ventral Hernia

Hernia through the linea alba (except at the umbilicus), the linea semilunaris, or some other part of the abdominal wall that is not usually weak. It may be the result of defective development, or it may be due to operations, injuries, extreme distension, rupture of muscles, abscesses leaving a yielding cicatrix, or, in short, anything that impairs the strength of the part. It must be treated in all respects like umbilical hernia. Strangulation is rare, although I have met with instances of it. Herniæ of the subperitoneal fat may occur in the middle line, and have been known to cause symptoms of strangulation from dragging upon the peritoneum beneath.

Obturator Hernia

Hernia through the obturator canal in the upper and outer part of the thyroid foramen is always acquired, is much more common in women than in men, and rarely occurs until middle age; apparently it is connected with the emaciation and loss of fat which often follow the climacteric. It protrudes either between the obturator externus and pectineus, or through one or other, stretching the fibres over it, and causes an indefinite fulness in the groin, behind and to the inner side of the femoral vessels, between them and the adductor longus. The obturator artery and vein may lie either to the inner or outer side, the relation they bear to the neck of the sac being very inconstant.

This form of hernia is rarely recognised unless it is strangulated. It is always small and deeply buried; and, unless there is pain along the obturator nerve, there is little or nothing to direct attention to it. If strangulation sets in the symptoms are generally acute; the inner side of the thigh is tender and painful; sometimes, if the patient is thin, a certain amount of fulness may be made out, especially when the hips are slightly flexed and abducted; the muscles of the abdominal wall are rigid, and the movements of the thigh are attended with pain. Vomiting and collapse usually come on at once and are very severe. In about half the cases there is a complaint of pain running down the inner side of the thigh to the knee-joint, or even into the leg, evidently due to the pressure upon the nerve; but in many instances this symptom has not been noted. Examination *per vaginam* is stated to have been of assistance in the diagnosis.

Taxis has been successful in a fair number of cases. The thigh should be flexed, adducted, and rotated a little inwards to relax the muscles around the hernia as much as possible; and the pressure must be applied from below upwards. If this fails to give relief and the symptoms point to strangulation, an incision should be made to the inner side of the femoral vessels, parallel to them, commencing immediately below Poupart's ligament, and the pectineus muscle exposed. The fascia covering it is divided, the muscular fibres separated and held apart, and the finger passed down to explore the upper and outer part of the obturator canal. If the sac can be made out it must be separated from the tissues around and opened so that the condition of the intestine may be assured. The stricture is divided by cutting either directly downwards, or a little downwards and outwards. In several instances the local symptoms have been so obscure that abdominal section has been performed for the relief of strangulation.

Other varieties of hernia are very rare, and possess but slight surgical interest.

Diaphragmatic hernia may be either congenital or acquired. In the former case the protrusion takes place by the side of the ensiform cartilage, between the costal and xiphoid portions of the diaphragm, or through some accidentally weak part, and it is usually covered with a sac. In the latter, which is much the more common, any part of the diaphragm may give way and allow the intestines to be forced through the rent into the pleura.

The congenital form scarcely admits of diagnosis: in the acquired one, if the amount of the protrusion is very great (and, occasionally, the stomach, spleen, part of the liver, and a considerable proportion of the intestine are forced into the pleural cavity), death, generally speaking, occurs at once from the interference with the thoracic viscera; in other cases, if the patient survives, there is great distress, arising from the displacement of the organs and the adhesions that form between them; and strangulation may occur.

Perinæal hernia.—In this the protrusion takes place either between the bladder and rectum, or the bladder and vagina, according to the sex. Usually it passes through the fibres of the levator ani and forms a soft, easily reducible swelling to one side of the middle line.

Pudendal hernia may occur in women past middle life, the sac descending between the ramus of the ischium and the vagina into the posterior part of the labium. It might be mistaken for a labial cyst.

Sciatic hernia has been described by Astley Cooper, the rupture lying between the pyriformis and the spine of the ischium.

Lumbar hernia occurs in Pott's triangle, the small space bounded by the external oblique, the latissimus dorsi, and the crest of the ilium. It must either pass through the aponeurosis of the transversalis and the internal oblique, or stretch them gradually before it as coverings of the sac.

SECTION IV.—INTESTINAL OBSTRUCTION

INTESTINAL obstruction includes all cases of internal hernia, strangulation by bands, twisting, intussusception, stricture and impaction. For clinical purposes these are divided into two great classes.

In the one the onset is instantaneous, and the chief symptoms are due to the effect upon the nervous system. The patient is in perfect health: suddenly and without warning, some part of the bowel is caught or twisted; the circulation is stopped; the great nerve-plexuses are thrown into a state of violent disorder; vomiting, collapse, and pain, come on at once; the vomit rapidly becomes fæcal; the prostration is complete; and, if the patient does not sink from exhaustion, the intestine becomes gangrenous in the course of a few days.

In the other the onset is gradual, and the symptoms for a time ill-defined; the health often has been failing; there have been previous slight attacks of a similar character, at first relieved easily, then with greater difficulty, until at length absolute obstruction and distension of the abdomen set in. Pain is present, but it comes on spasmodically and grows more and more intense. Vomiting, when it does occur, is due to the accumulation of food, not to the effect upon the nervous system; but the case may run a course of weeks without its happening once. Collapse does not come on until the end is approaching.

It must not be imagined, however, that every case can be included at once under one of these headings; the diagnosis of the cause and of the seat of intestinal obstruction is one of the most difficult in surgery, and often an operation has to be performed with the double object of exploration and relief.

Occasionally the aspect of a case changes suddenly: chronic obstruction becomes acute, the symptoms become infinitely more severe, and the patient sinks from prostration, the more rapidly because of the exhaustion caused by the previous illness.

ACUTE INTESTINAL OBSTRUCTION, OR INTERNAL STRANGULATION

The symptoms acute and the strangulation sudden, as in external hernia.

Causes.—The most useful classification is that adopted by Treves:—

1. Internal hernia and strangulation by bands of all kinds.
2. Volvulus.
3. Acute intussusception.

4. Sudden obstruction due to gall-stones, or impaction of fæces, with or without previous narrowing of the bowel. Stricture, in most instances, is gradual; but, occasionally, the closure suddenly becomes complete, and the symptoms assume an intensely acute character.

1. *Internal hernia and strangulation by bands.*—Pouches, which may become hernial sacs, are occasionally developed from depressions on the posterior wall of the abdomen. One of these is the *duodeno-jejunal* fossa, caused by the fold of peritoneum covering the inferior mesenteric vein; another is the *subcæcal*, to the inner side of the cæcum, bounded above by a fold passing from the promontory to the cæcum; and there may be a third, the *intersigmoid*, between the left ureter, the superior hæmorrhoidal vein and the spermatic vessels. In other cases a pouch is formed by the yielding of the wall at one spot, the fascia covering the iliacus, for example, so that the peritoneum protrudes into the tissues beneath.

Rings and loops are sometimes present in the peritoneal cavity. A hernia has been known in the foramen of Winslow; but, more frequently, the opening is abnormal, in the mesentery or the omentum, or in a sheet of lymph thrown out during an attack of inflammation.

Bands and adhesions are more common. Pelvic peritonitis in women, and typhlitis in men, are the causes in most of the cases. In some the omentum is fixed to the pelvis and rolled up into the shape of a fan; this occurs more often in men, partly owing to the typhlitis, partly to the frequency of hernia. In others there is a tough fibrous band thrown across from one part to another at the back of the abdomen; or two distant loops of intestine become connected together by an adhesion which, as they separate, is stretched out into a narrow cord; or, again, a portion of intestine, the appendix vermiformis, for example, or the pedicle of an ovarian tumour, or even a Fallopian tube, is tied down in such a way that a small space is left behind. No matter how it is produced, when a band of any kind is present, there is always the danger of strangulation. The intestine slips under it, sometimes in a great coil, and either becomes congested or else twisted upon itself so that it cannot return; in a very few hours it becomes loaded; the veins are constricted, and the circulation stopped. In rare instances the traction of a band upon one side of the intestine has caused it to bend so acutely as to close the lumen; and the same thing has occurred from the bowel being compressed or held in a bent position, or even from

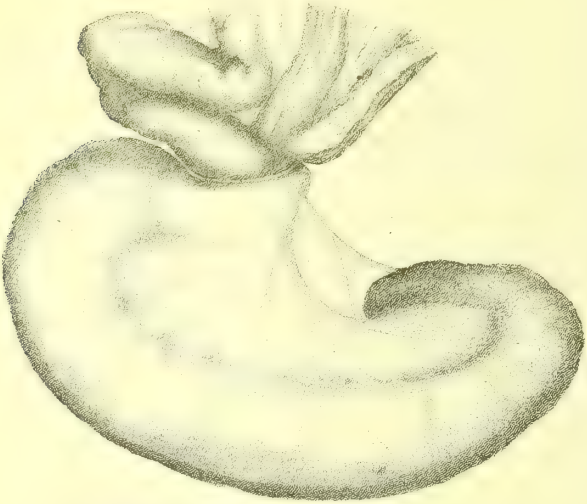

FIG. 375.—Strangulation of small intestine by band.

its being tied down by adhesions, especially when it is doubled into a loop.

Bands that are long and loose, or that are attached only at one end, are scarcely less dangerous ; in the former case they are sometimes thrown into a kind of spiral coil, through the centre of which a loop of intestine may descend. Probably, as Treves has pointed out, this is of little consequence so long as the intestine is healthy ; but if the sides of the loop are adherent to each other, or if the bowel is held by adhesions doubled upon itself, the neck is very likely to be narrower than the rest, and strangulation is highly probable. When one end is unattached, a knot, sometimes of a very complicated character, may be formed around the bowel, and lead to the same result. One end is free and slightly enlarged ; this slips inside a loop formed by the rest, the intestine pushing it on until at length the knot is drawn tight and the bowel strangulates itself.

Meckel's diverticulum, the remains of the vitelline duct, is an especial source of danger. Springing from the ileum a short distance above the cæcum, it is directed forwards towards the umbilicus. Sometimes it is a tube resembling the small intestine, and opening on the exterior ; more often it projects two or three inches, and ends in a fibrous cord ; or the end is free and enlarged or club-shaped ; or it may have secondary attachments elsewhere. It acts like a peritoneal band : if it is fixed at both ends a loop of intestine may slip beneath and be twisted on itself and strangulated ; it may coil itself into a loop, or if the end is enlarged and free it may knot itself into a snare ; in a few cases a loop of intestine has fallen over it and become acutely bent ; in one or two instances it has exerted such traction upon the intestine as to close the lumen completely ; and finally it may allow the intestine to become extruded through it ; the mucous membrane is prolapsed first, and this is followed by more and more of the bowel, until there is a huge intensely congested protrusion, turned inside out, projecting through the umbilicus. In one case of this kind I was obliged to open the abdomen before the mass could be reduced (fig. 376).

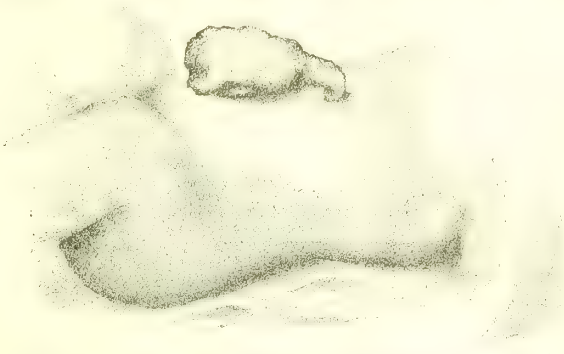

FIG. 376.—Prolapse of intestine through Meckel's diverticulum.

Strangulation by bands or through apertures form, according to Treves, one-fourth of the total number of cases of intestinal obstruction from all causes. Of these more than one-third are due to false ligaments, about one-fifth to the omentum, and rather more than one-fifth to the presence of Meckel's diverticulum.

2. *Volvulus.*—Of this there are two forms. In the more common, a loop of intestine, the ends of which lie close together, is twisted around its long axis; in the other, two distinct loops are twisted around each other. A third, very rare form, twisting on its own axis, has been described in the colon.

Owing to its anatomical relations the sigmoid flexure is the common seat of volvulus; but it cannot occur even here unless the mesentery is elongated, and the ends of the loop dragged close together by long-continued distension. For this reason it rarely occurs under middle life, is almost unknown in children, and is usually preceded by chronic constipation. It may happen to the cæcum, when, owing to the persistence of a fœtal condition, there is a long mesocæcum and mesocolon; and to the small intestine, if a loop becomes tied together and fixed by adhesions; but these are very rare.

The second form of volvulus may affect the same regions; but it is very uncommon.

The immediate cause is probably some sudden movement of the body; the effect is a tight twisting of both ends, leaving the long and heavy loop hanging down without any power of recovering itself. In some instances the pressure of the anterior abdominal wall seems to retain it. Venous congestion sets in at once; the loop becomes enormously distended with gases that are set free in it; it may even reach the diaphragm, and by its pressure prevent the swelling of other portions of the intestine; peritonitis is almost invariable, and sets in exceedingly early; and ulceration of the mucous membrane in the bowel above the seat of constriction, or gangrene of the loop, follows rapidly. At first the coil can be untwisted without much difficulty, but after a little while the walls become so dense that it rolls back as soon as the pressure is taken from it. Volvulus may prove fatal within forty-eight hours.

Volvulus may occur after the reduction of a strangulated hernia, causing persistence of the symptoms; and in the case of bands strangulation is often the result of the combination, the band and the twist.

3. *Intussusception* is the prolapse of one part of the intestine into the interior of another immediately adjoining. It is a very common form of obstruction, making up very nearly one-third of the whole; and, owing to the mobility of the intestines in children, is especially frequent among them. More than half the cases occur under ten years of age.

If a section is made through an intussusception, three layers of intestine are divided, the innermost or entering layer; the outermost, or sheath; and the middle or returning one, in which the mucous surface is outside, facing the mucous surface of the sheath, and the peritoneal inside, facing that of the entering layer. The two inner layers are known as the intussusceptum. In exceptional cases five and even seven layers are met with.

The mesentery of course is carried in with the bowel, lying between the peritoneal surfaces of the inner layers, and dragging the intussusception into a cone, the apex of which lies at the point, the base at the neck. A certain amount of elongation is necessary to allow this, but, owing to the direction taken by the bowel, not so much as might be expected; and as an ileocæcal intussusception can reach the rectum within a few hours, the increased length is not due merely to stretching. The effect of this traction is, in general, to throw the intestine into a curve, and to tilt up the orifice of the intussusceptum, so that it has the aspect of a slit and looks towards the side of the bowel rather than down the axis.

Intussusception exists in two different forms. In the common one, the apex of the invagination never changes; the part that entered first continues in front throughout, and the increase is entirely at the expense of the sheathing layer; in the other (ileocolic), which only occurs at one part of the intestine and is rare there, the ileum slips farther and farther down the colon through the valve, without the cæcum following it; the increase is entirely at the expense of the small intestine, and the apex is constantly shifting. Not unfrequently after a time this variety changes into the other.

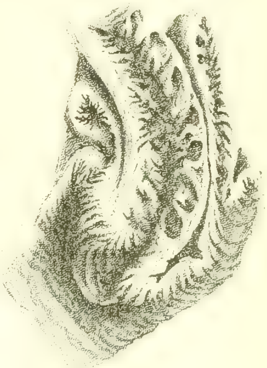

FIG. 377.
Double intussusception.

The ordinary form may be enteric, ileocæcal or colic. Of these the first and last are seldom met with, and are rarely of any length; the second is the usual one, the ileocæcal valve forming the apex, and gradually passing through the colon and rectum until perhaps it protrudes at the anus. The frequency with which intussusception takes place at this spot is due to some extent to the difference in size between the two parts, and to the fixed position of the cæcum, but, as Leichtenstern and others have pointed out, there is a very close analogy between the sphincter-like ileocæcal valve and the sphincter of the rectum, and between the invagination that takes place at the one and the prolapse that occurs with equal frequency, especially in children, at the other. Ileocæcal tenesmus probably sets in whenever there is any violent catarrh or abnormal irritability of the intestine, just as anal tenesmus occurs in similar conditions of the rectum; and the repeated and forcible peristalsis, driving down on to the firmly closed ileocæcal valve, causes intussusception in the one case, just as it causes prolapse of the rectum in the other. If the cæcum is freely movable, as it usually is in children, ileocæcal intussusception occurs; if, on the other hand, it is fixed, as in adults, ileocolic. When once the invagination has commenced, the contact of the swollen and congested apex, stimulating the walls of the intestine below, tends to make it increase indefinitely.

In upwards of one-half the recorded cases of intussusception no exciting cause can be found. It is undoubtedly more common in delicate patients than in those who are strong and robust; and in most instances where there is a definite reason for its occurrence, it has followed diarrhœa, free purgation, or colic due to the presence of undigested food. Possibly slight degrees of it, undergoing spontaneous reduction, occur more commonly than is usually imagined in severe colic attended with great prostration. In a few instances it has followed injury, blows upon the abdomen, or jumping a child up and down, and there is no doubt that the presence of fibrous polypi in the intestine predisposes to it. The relation that exists between intussusception and epithelioma is more doubtful. In several cases the apex has been found to be the seat of malignant disease, and in one the convexity of the curve was involved, but it is difficult to say whether this was the cause or the consequence, due to the prolonged irritation.

The method of production, according to Nothnagel, is much the same whether the intussusception is due to paralysis or to spasmodic contraction (which is the more usual of the two), affecting one segment of the bowel. The intestines above scarcely take any share in the proceeding; the longitudinal muscular fibres simply keep drawing the bowel from below, over the narrowed part, until an invagination is produced and the apex has become swollen and congested. True intussusception must be distinguished from the invagination which is not uncommonly found in the bodies of children who have died from cerebral disease. Several of these may occur together, they are never of any size, and can always be reduced without difficulty. Probably they are due to the disorderly character of the peristalsis when the circulation is beginning to fail.

Effect.—This chiefly concerns the invaginated part and its mesentery; the sheath may escape altogether, although sometimes it becomes gangrenous, and the part above at first shows scarcely any change; later it may be dilated and the walls hypertrophied, or ulceration may occur and end in perforation. It all depends upon the character of the constriction; where this is very tight the bowel inside becomes intensely congested, blood pours out from the mucous membranes, the walls become thickened and almost solid, especially along the convexity and at the apex, and the intussuscepted part soon becomes gangrenous. The middle layer usually suffers the most severely; in some instances the whole invagination is destroyed and comes away in a mass, the separation taking place at the neck; more frequently it is detached in shreds, and occasionally the inner coat is gradually cut off from the rest, unfolded, and passed with the middle layer, turned inside out.

Where the constriction is less severe a low form of inflammation sets in, the walls become thickened, adhesions form between the peritoneal surfaces, sometimes at the neck only, but more frequently wherever they are in contact, and if the patient lives the whole of the intussuscepted part may at length slough off. Obstruction is not common, in spite of the thickening of the walls and the way in which the orifice at the apex is dragged to one side by the mesentery. Very often the intussusception is irreducible, even when there are no adhesions—the walls are so thickened, especially along the convexity, and the apex is swollen out to such an extent, that the tissues cannot be unfolded without being torn. The same result may follow from twisting of the bowel inside the sheath, from rigid contraction of the ileocæcal valve, or from the presence of a fibrous polypus springing from the mucous membrane.

Where the constriction is very lax there may be scarcely any alteration even after months, but not unfrequently after some little time the symptoms suddenly change and become acute. Peritoneal adhesions are more common in chronic than in acute cases, and often render reduction impossible; according to Treves they are present in no less than eighty per cent. Sometimes they are only at the neck, or they may be general, or limited to the part first invaginated, so that the whole can be reduced with the exception of the last few inches. The walls of the bowel above are hypertrophied; sometimes there is considerable distension, owing to the narrowing of the passage by the swelling and bending of the intussuscepted part. Ulceration may occur, but when the bowel becomes gangrenous the process is usually more gradual than in acute cases; it may involve the mucous membrane only, or it may begin at the apex of the invagination and extend slowly upwards until in some extreme instances the greater part or even the whole of the large intestine has sloughed, leaving the ileum continuous with the rectum.

4. In *stricture of the intestine* the symptoms sometimes undergo a sudden change, become intensely acute and resemble those of strangulation. This

may depend upon a variety of conditions: the narrowed part may have become blocked; a fold of mucous membrane may have fallen over the orifice; the bowel, especially in the case of the small intestine, may have suddenly become bent upon itself, and closed the passage; or, if the obstruction is below the sigmoid flexure, and this becomes greatly distended, volvulus may suddenly set in and cause a fatal termination within a few hours. As a rule, the symptoms are hardly so abrupt or so violent as those of strangulation, and nearly always there is a history of previous trouble and of similar slighter attacks. If the onset is sudden and the symptoms acute, as occasionally happens, especially in stricture of the small intestine, there is no means of diagnosing one from the other.

Gall-stones which have ulcerated through into the duodenum, fæcal accumulations, and very rarely foreign bodies, may cause symptoms of strangulation, even when there is no stricture; but, in this case again, it seldom happens that they are so acute or the collapse so extreme. A fatal result, however, has been known to occur from this cause within four days, and the average duration of acute obstruction by impacted gall-stone is only seven.

Symptoms.—These conditions are grouped together because they are sudden in their onset, and because, with certain exceptions, they present the characteristic features of intestinal strangulation, collapse, pain, vomiting, and constipation. Of these the two first are always present, the others are not so constant; vomiting, for example, does not always occur in volvulus, or only makes its appearance towards the end, while diarrhœa with a discharge of blood and mucus from the anus is the rule in acute intussusception.

(*a*) *The collapse* is most striking in internal hernia, strangulation by bands, and acute intussusception. The patient is utterly prostrate; the temperature falls; the pulse is feeble and rapid; the face is pinched, the eyes sunken, the extremities cold, and the secretion of urine diminished. The severity depends to some extent upon the part involved; it is more marked, for example, in the small than in the large intestine, and nearer the pylorus than at the lower end, but the amount caught and the tightness of the constriction are even more important. In volvulus the prostration may prove fatal in two or three days, but as a rule it comes on more slowly and reaches its maximum gradually.

(*b*) *Pain* is never altogether absent, although it varies in character and severity. When strangulation is the prominent feature, and the peritoneum and the walls of the bowel are crushed together, it comes on at once and lasts throughout, varied only by attacks of colic, which, as in strangulated hernia, are especially severe when the abdomen is examined. If, on the other hand, the symptoms are due to gradual narrowing of the bowel, as in chronic obstruction, the pain from the first is of a peculiar griping character, coming on at intervals, with periods of repose and comparative comfort between. Later, as the obstruction becomes complete, the attacks grow more and more frequent, and the intervals shorter, until at length it is continuous with, every few minutes, violent storms of colic, often visible on the abdomen, as the coils of intestine move over and over. Tenderness is seldom present, unless peritonitis has set in or there has been severe cramp affecting the abdominal muscles.

(*c*) *Vomiting.*—As in external hernia, this is reflex, caused by injury to the intestinal nerves. In acute strangulation it begins at once, and persists without ceasing; first the contents of the stomach, then those of the duodenum, and, after a time, of the lower part of the intestine. Towards the end it becomes fæcal, if the obstruction is low down in the ileum, or if the contents of the bowel are retained sufficiently long for decomposition to set in. In volvulus, on the other hand, vomiting may not be present at all, or it may be very scanty and even give a certain amount of relief.

(*d*) *Constipation*, in most cases, is absolute. Even when the sigmoid flexure is full of fæces, there is usually no evacuation, owing to the profound effect upon the nervous system. Acute intussusception, however, must be excepted; in this absolute constipation is very rare; diarrhœa is the rule, and nearly always there is a discharge of blood and mucus with violent tenesmus.

These symptoms are common, more or less, to all forms of acute intestinal obstruction; others are less general and serve to distinguish one variety from the other.

Internal strangulation, however produced, presents the closest resemblance to strangulated hernia. It usually occurs in young adults; the onset is sudden, the collapse, pain, and vomiting (which soon becomes fæcal) are characteristic; constipation is absolute from the first; there is no tenesmus or tenderness on pressure (until peritonitis sets in); meteorism is absent; the coils of intestine cannot be seen through the wall, and no tumour can be felt. As bands are the most common cause, there is a history of previous peritonitis, or perityphlitis, or of the reduction of a strangulated (external) hernia, in a very large proportion of cases.

Volvulus, as compared with this, very rarely occurs before forty, is far more common in the sigmoid flexure than elsewhere, and is usually preceded by chronic constipation. The onset is sudden and the pain severe; but vomiting does not commence at once, and, unlike that of strangulation, it may give a certain amount of relief. Tenesmus is occasionally present. The immense distension of the affected bowel, the extreme prostration, and the rapid occurrence of peritonitis are the most important features. The abdomen becomes distended until the diaphragm can scarcely act; the muscles are tense and rigid, and the walls exquisitely tender; sometimes there is dulness on percussion at the back, but, as a rule, it is resonant all over; no coils of intestine can be seen and no sign of any tumour. It is possible that manual examination of the rectum and enemata may be of some use in the diagnosis of the ordinary form.

Acute intussusception stands in great contrast to these; more than half the cases occur under ten years of age, and a very large proportion in infants. Like the others, the onset is sudden, attended with pain, usually distinctly paroxysmal, and great prostration; but the vomiting is not so constant and does not occur so early as in internal strangulation, and absolute constipation is hardly ever present. Diarrhœa is the rule, and in more than eighty per cent. there is a discharge of blood and mucus from the anus with well-marked tenesmus. A sausage-shaped tumour can be felt in a large proportion, sometimes through the rectum (in which case it bears a close resemblance to the os uteri), more often through the abdominal wall, in the line of the colon; it varies much in distinctness and becomes especially plain during an attack of colic. The region of the swelling is nearly always tender from the first; no coils of intestine are visible, and meteorism and abdominal distension are not marked until the peritonitis has spread from the region of the intussusception and become general. Intussusception in infants, if the parts are very tightly constricted, may prove fatal from collapse in forty-eight hours.

Sudden obstruction, due to impacted gall-stones or the closure of a stricture, can only be distinguished from internal strangulation by the previous history.

Diagnosis.—Acute intestinal strangulation must be distinguished from perityphlitis and peritonitis (especially that form which is due to ulceration of the appendix), and from certain other conditions which, owing to the effect they produce upon the great nerve-plexuses, give rise to symptoms of a closely similar character (pseudo-strangulation).

With the former of these there is rarely any difficulty, provided the case is seen from the first and the history is known. *Perityphlitis* seldom begins without some previous indication ; there may have been irregularity of the bowels, or an attack of indigestion ; local tenderness in the iliac fossa is an early symptom ; sometimes there is a distinct feeling of resistance in the same place, or even a certain amount of swelling ; very often there is a history of previous attacks of a similar nature, and usually there is a slight but distinct rise of temperature from the first. *Peritonitis*, again, of such a nature as to be mistaken for acute intestinal strangulation, is always severe, and attended from the first with fever, distension of the abdomen, and intense continued pain. Ascites very soon makes its appearance, the vomiting is of a different character, the skin over the whole surface is exceedingly tender, and, if it is due to perforation, gas very soon collects in the abdominal cavity, and causes a diminution in the hepatic dulness. If, however, the patient is not seen until the peritonitis is already general, or if, as frequently happens in such cases, the patient is too exhausted to give any account of his symptoms, the diagnosis of the cause is impossible.

In *pseudo-strangulation*, on the other hand, or where a part of the bowel s paralysed, and the symptoms are due, not to inflammation but to the ffect upon the nervous system, the diagnosis is often very difficult, and cases re not unknown in which all the characteristic signs of internal strangulaion have been present and have terminated fatally, without any evidence of nechanical obstruction being found after death.

Paralysis of one segment of intestine may be the direct result of injury, r may be reflex. Instances of the former (*ileus paralyticus*) are not uncomnon after the reduction of strangulated hernia, and probably the cases in which ecal vomiting and other signs of acute strangulation have occurred in the ourse of typhoid and other diseases that involve the coats of the bowel, or ven after injury to the abdomen, are to be explained in the same way ; the owel is so much injured in one spot that it practically acts as a stricture hich has suddenly become impassable.

In other cases the paralysis is reflex, excited by some distant affection, nflammation of a retained testicle or of a hydrocele, or phlegmon of the nterior wall of the abdomen, and the symptoms subside as soon as the pain nd irritation are relieved. In neither case does the paralysis of the intestine, owever produced, account for more than vomiting and constipation ; the olence of the pain, the severity of the vomiting and the collapse, are the sult of reflex disturbance, starting from the damaged nerves in the bowel, volving the great abdominal plexuses.

Symptoms of a similar character occasionally arise from disease of the nervous system, hysteria for example, although chronic obstruction is more common. Tubercular peritonitis, meningitis, hepatic and renal colic, dysentery and various other affections, have at times caused a certain amount of difficulty in diagnosis.

Treatment.—In acute intestinal obstruction the first object is to release the bowel, whether it is strangulated by a band, twisted on itself, invaginated into another segment, or blocked in such a way as to cause the same symptoms. Except possibly in this last mentioned case, it is of little avail merely to secure the discharge of the contents by opening the intestines above (in volvulus it is done with the hope of uncoiling and releasing the twist); the benefit obtained is only transient, the cause is not removed, the nervous symptoms are not relieved, and gangrene with fatal peritonitis is practically inevitable. It is true that a few cases of wonderful recovery without active treatment are recorded; but the number is exceedingly small, and if the patient is left the chances of spontaneous reduction or of recovery with an artificial anus are infinitely less than in external strangulated hernia.

The more sudden the onset and the more marked the nervous symptoms, the more urgent is the need for active treatment. When the commencement is gradual, preceded, perhaps, by other symptoms, the difficulty is greater; but the possibility of an acute termination to a chronic affection must always be borne in mind, and if no diagnosis can be made, and the patient's condition admit of it, an operation should be performed for exploration before it is too late.

1. Where all the characteristic signs of acute intestinal strangulation are present, with sudden onset and symptoms urgent from the first, as in strangulated external hernia. Such a condition may arise from internal hernia, strangulation by bands, omentum, or Meckel's diverticulum, sudden obstruction from kinking, looping, traction, or twisting (volvulus) of the small intestine, from ileus paralyticus or other affections attendant on taxis; or exceptionally from stricture, impaction of foreign bodies or compression by some external tumour. There is no method at present by which it is possible to distinguish one of these from the others; the symptoms are practically the same; and if unrelieved they all end in the same way—gangrene and peritonitis, which prove fatal, as a rule, in the course of five or six days.

The patient should be kept absolutely at rest and as warm as possible; exposure to cold, especially during the operation, is exceptionally serious, owing to the collapse; no food may be allowed, only a fragment of ice to allay thirst, but an enema of brandy may be given with advantage, and if the patient has had no opium a small injection of morphia hypodermically. The effect of this is wonderful: the pain is relieved, the severity of the vomiting diminishes, the skin becomes warmer, the collapse passes off to a certain extent, and the secretion of urine begins to increase. Care, however, must be taken not to mistake the nature of the improvement; the opium relieves the collapse so that the patient appears to rally; it does not remove the cause. This, as in external hernia, can only be done by operation: enemata, massage, and the other methods of treatment that have been advocated from time to time, are worse than useless; they cause delay and inflict further injury.

If the diagnosis is definite, the sooner the operation is performed the better; if it is postponed until the condition of the patient is hopeless it is not to be blamed for the result.

If the vomiting is severe or the stomach much distended, an œsophageal tube should be passed and the cavity washed out with hot water. An anæsthetic is only really necessary for the preliminary incision, and the patient should never be anæsthetised to complete insensibility.

The incision should always be made in the middle line below the umbilicus, a catheter having first been passed to make sure that the bladder is empty. The whole of the abdomen may be explored from this point, there is very little bleeding, no important structures are divided, any part of the small intestine may be brought out through it (except the fixed part of the duodenum), a portion of the colon even has been excised (Treves), and it is practically impossible in the vast majority of cases to localise the seat of strangulation.

An incision two inches in length is sufficient; the superficial structures are divided, the peritoneum and the wound extended sufficiently with scissors or with a scalpel, using the fingers as a director; and the gap is filled at once with a loop of bowel more or less congested.

In the easiest cases, where, for example, the strangulation is dependent upon an umbilical band or Meckel's diverticulum, the diagnosis can be made at once with the finger. More frequently nothing can be felt. In this difficulty the coils of small intestine lying near should be carefully inspected and the one that is most congested allowed to protrude into the wound, hot sponges, renewed as soon as they become cool, being used to protect and control it. It is true that exposure of the intestine is, as a rule, to be most carefully avoided; if the bowel is allowed to become cool, or even if it is exposed to the air for any length of time, the gravity of the operation is immensely increased, but it is a choice between evils, and probably the protrusion is the least.

It need not be a great coil; nearly always by gently moving it about it can be seen which of the ends is the more congested and dilated, and this guides infallibly to the seat of strangulation. Usually it is not far off, for, as Greig Smith has pointed out, the greater amount of bowel is within three inches of the umbilicus, and the most dilated coils rise to the surface. Sometimes, as was first pointed out by Rand of Liverpool, it is possible to make out which is the upper end of the loop, and even whether it belongs to the nearer or more distant part of the small intestine, by passing the finger down to the root of the mesentery against the spinal column.

If the distension is too great to allow exploration, either the intestine must be punctured with a capillary trocar in many places to let out the air, or an incision made in the protruding loop in order to empty the neighbouring segments. Of these methods the former is scarcely safe; leakage is very likely to occur from paralysis of the walls of the intestine. It has been done through the wound, and, guided by the hand, through the abdominal wall at some distant spot; but to afford effectual relief it must be practised at many points. The other method is strongly advocated by Greig Smith, not only to allow of exploration, but as a means of relief; he points out that in such cases as these the mere distension of the intestine is sufficient to perpetuate he obstruction; the bowel no longer lies in gentle curves, but forms acute lexures which act as valves and prevent its being emptied even after death, and he compares this with the benefit which often follows the use of Kussmaul's œsophageal tube. In short, he regards evacuation of the intestinal ontents as an essential part of the operation. The loop of bowel is secured o some strapping fixed on the front wall of the abdomen by means of four quilt sutures passing through the serous and muscular coats, and an aspirator trocar and cannula introduced into the centre of the square marked out. Evacuation may take an hour or more, the abdomen being gently kneaded the whole time, but as soon as the skin incision is made and the sutures passed the anæsthetic should be discontinued.

As a last resource, when nothing can be found, even after the distension is relieved, the opening may be enlarged (if the patient's condition will admit of further exploration), the hand introduced, and the hernial openings, the cæcum, and then, according to its condition, the colon or the small intestine carefully traced back, beginning with a part that is empty and collapsed, until the seat of strangulation is found.

The actual constriction rarely presents any difficulty; small bands can usually be broken down with the finger; longer ones may require division, and in such cases it is as well to ligature them near their attachments and remove them; omentum may be treated in the same way. Meckel's diverticulum, if it has to be divided, should be treated like a portion of intestine, the end invaginated, and the serous and muscular coats sewn together over it. When stricture, or the impaction of a gall-stone or other foreign body, is sufficiently acute to cause symptoms of strangulation, the bowel may be opened and the obstruction removed, or the stricture resected as the case may be. In one or two instances an impacted gall-stone has been gently passed on through the ileo-cæcal valve, and Tait has suggested that, as they are very brittle, it might be possible to crush them or split them with a needle. It seldom happens, however, that the condition of the walls is sufficiently good to allow this to be done. In many cases it is wiser to be content with the formation of an artificial anus, which may be dealt with later, when the patient has recovered. The same thing should be done when the state of the bowel is such that its recovery is a matter of question.

Treves has pointed out that, even when one constricting band has been divided and a definite strangulation relieved, it is always as well to make sure that there is no second. Instances of twofold strangulation by bands have occurred on more than one occasion.

The subsequent steps in the operation present no special feature. If the constriction has been found, and there has been no hæmorrhage or escape into the peritoneal cavity, the less the parts are disturbed the better; the wound must be closed as in other operations. If, on the other hand, there has been much bleeding, the cavity may require to be sponged out, and if any of the intestinal contents have escaped, it must be thoroughly irrigated with hot water. Drainage must be provided for if peritonitis is present at the time or is expected to follow.

In many cases the condition of the patient is much too critical to stand any prolonged or systematic exploration; the face is drawn and pinched; the pulse very rapid and scarcely perceptible; there is dulness in the flanks, the coils of intestine being filled with fluid; the stomach is distended with fluid and gas without the patient having strength to vomit it up; and there is complete apathy and almost insensibility to pain. In such as these Greig Smith recommends an injection of cocaine, a small incision, and, if the seat of strangulation is not apparent at once, suturing the intestine as already described, so that it may be emptied of its contents. It may give relief for a time until the patient rallies, and it is not possible to do more.

The after-treatment must be conducted on the same principles as in external herniotomy. The blankets must be warmed, and hot bottles kept round the patient; the temperature, which is not unfrequently subnormal before the operation, is often still further reduced by shock and exposure, and by the anæsthetic; moreover, life has to be sustained on a minimum of food. Nothing may be given by the mouth for at least forty-eight hours; only small fragments of ice at long intervals to allay the thirst; and even at the end of that time food should only be given by the spoonful. The strength must be maintained by small enemata of peptonised food with brandy every three or four hours, so as to allow the intestine ample time for recovery, and the patient must be kept under opium. Hypodermic injections of morphia are the most useful, as there is never any question how much has been lost if the patient should be sick; but the tincture, with an equal quantity of water is sometimes preferred; and this must be continued until there is no longer any fear of the intestine giving way, or of peritonitis.

The prognosis depends, as in strangulated hernia, upon the condition of the bowel; but there is not as yet a sufficient series of cases to form any estimate as to the probable mortality. It is manifestly unfair to include those (and they form by far the majority) in which the operation has been done as a last resource, when everything else has been tried, when the patient is in a state of collapse, and general peritonitis has set in; sometimes even under these circumstances it has proved successful, and there is no reason why, if it were done before the bowel is too much injured and the patient's strength exhausted, the mortality should be much higher than after external herniotomy.

2. *Volvulus*, when it affects the small intestine or the cæcum, cannot be diagnosed from the preceding; if such a condition is found after laparotomy, an attempt must be made to uncoil the bowel, or, failing this, the loop must be emptied through an incision and an artificial anus formed.

Volvulus of the sigmoid flexure has never been known to recover without operation, though in one case (quoted by Treves), which terminated fatally at last, the patient had suffered from many previous attacks of colic, but had always been able to obtain relief by lying in one special position. If the case is left to itself peritonitis is invariable; the distension becomes immense; the serous coat gives way; and gangrene ensues, unless the patient dies first from asphyxia or collapse. In the very early stages it is possible that, if the coil is exposed through an abdominal wound, it may be untwisted and gradually emptied; but if there is much distension, and the walls are thickened and congested, either this cannot be done, or, if it is accomplished, the bowel at once resumes its former position. In such a case the coil of intestine must be laid open and secured to the wall of the abdomen, so that it may empty itself thoroughly. Possibly after this has been done the circulation will recover, and the passage from above be restored; if not an artificial anus must be formed. If the patient recovers, the greatest care must be taken not to allow the bowels to become confined or the colon loaded.

3. *Acute intussusception* differs from the other forms of intestinal strangulation in the fact that a certain proportion of cases recover spontaneously, the bowel either releasing itself or becoming gangrenous and sloughing off. How often the former of these occurs it is impossible to say; probably it takes place in many of the cases of severe intestinal colic, in which opium gives such complete relief, but there is no means of proving it. The latter, as Treves has pointed out, is too exceptional an occurrence, especially in the young, to deserve any reliance; and it is probable that it is much more rare

than statistics show. Besides, even when it does happen, over forty per cent. of the patients die from effects directly connected with the process; the separation is premature; or the ulceration continues and leads to perforation; or hæmorrhage occurs; or the patient dies from prolonged exhaustion; stricture, sufficient to cause symptoms of obstruction, apparently is not proved.

In these cases opium is invaluable. In other forms of acute intestinal strangulation it relieves the collapse and places the patient in a more favourable condition for further treatment; but in acute intussusception it does much more: it stops the violent peristalsis; prevents the invagination increasing; diminishes the risk of congestion and strangulation; and occasionally relieves the spasm so completely that the symptoms subside of themselves and the bowel quietly regains its place. Unfortunately this result is only occasional, and great care must be taken that the symptoms are not merely concealed without the cause being removed. Unless every sign disappears and relief is complete, no reliance can be placed upon it.

Enemata are often successful in the early stages, especially when the large intestine only is concerned, and when the symptoms point rather to incarceration than strangulation. When the tumour is to be felt on the right side, or even in the middle line, the chances are much less; and if inflammation has set in and caused the formation of adhesions, or if the intussuscepted part has become thickened from long-standing congestion, success is out of the question: the bowel will give way sooner than unfold. They should not be tried if collapse and prostration are prominent features.

Insufflation with air has been recommended on the ground that the bowel is not so likely to be ruptured; on the other hand, water has succeeded (Waren Tay) after air has been tried and failed. Moreover, the quantity used can be measured more easily. The position of the patient is not material so long as the knees are well flexed; there is no advantage, that is to say, in inversion. An anæsthetic is generally advisable; in one case under my care reduction was effected easily when the muscles became relaxed, although the same injection had failed before. Siphon action is preferable to a syringe, the flow is uniform, and the pressure can be gradually increased to any required extent. It is essential that the fluid should enter very slowly and quietly, so that the bowel may have time to unfold itself, and it should not be allowed to escape again too soon. Regurgitation may be entirely prevented by means of Lund's insufflator, the ring of which stretches the margins of the anus and effectually blocks it. Gently kneading the abdomen at the same time, drawing the bowel down towards the anus from below the intussusception, is sometimes of assistance when the walls of the abdomen are thin and flaccid, as in a child, and when the swelling can be distinctly felt. By itself it is probably of little value. How much fluid should be used varies necessarily with every case, and no guide can be laid down.

When reduction is successful the tumour can be felt to slip away suddenly from under the hand, sometimes, but not often, with a gurgling noise; the abdomen becomes evenly and slowly distended, and the severity of the symptoms disappears at once; but of these signs the last is the only one upon which any reliance can be placed. The intussusception may apparently be reduced, but in reality be only concealed by the distension of the rest; or the apex may remain caught, owing to the way in which it is swollen; or the bowel itself may give way, and the contents suddenly discharge themselves into the peritoneal cavity.

If enemata fail, or if the intussusception persistently returns, the choice lies between leaving the bowel to itself while the patient is kept under the influence of opium, or performing laparotomy at once.

The duration of these cases varies very much: acute ones, especially in young infants and in the small intestine, may prove fatal within forty-eight hours; the majority last from four to seven days; some survive for longer periods still. The chances of spontaneous recovery, however, are exceedingly slight; in infants, according to Treves, elimination occurs in only 2 per cent.; and, between the ages of two and five, in no more than six; and even when this does take place the result is fatal in the majority. Between eleven and twenty years of age, on the other hand, the results of the expectant method are more successful; the deaths after spontaneous separation are only twenty-eight per cent.; but after that time, again, the chance of recovery becomes more remote. Clearly, therefore, so far as infants are concerned spontaneous recovery is very doubtful; and though the prospect may be better in youth and young adult life, it must be remembered that elimination, to commence with, does not occur in more than half.

There are no statistics showing the results of early laparotomy; in acute intussusception, if enemata fail, it should be done at once, within twenty-four hours, in the same way that herniotomy is done at once if taxis fails; it is of no use waiting until collapse or peritonitis has set in, or the patient's strength is exhausted; and the chances of an acute case becoming chronic, or, if it does become chronic, of the patient's surviving, are much too remote to deserve the least reliance.

The operation must be performed in the same way and with the same precautions as laparotomy for intestinal strangulation, the incision being in the middle line. When the intussusception is exposed an attempt must be made to draw down the sheathing layer from off it, using the utmost gentleness for fear of tearing the bowel, which is often much softened already; it is of no use, in most instances, trying to draw the intussusception out. Sometimes this succeeds at once; but, even after three days, it may be impossible, either from adhesions, from swelling and congestion of the invaginated part, from the way in which it is twisted and curved inside the other, or from the presence of a polypus. In such a case, or if the bowel is torn or gangrenous, the only choice left is primary resection, suturing the ends together; short-circuiting the intestine by means of Senn's approximation plates; or forming an artificial anus, leaving the intussuscepted part to take care of itself. The first, no doubt, is the ideal one, but in most cases that proceeding is advisable which can be accomplished most quickly and with least disturbance.

Chronic Intestinal Obstruction

The onset gradual and the symptoms due not so much to the reflex action of the nervous system as to the progressive narrowing of one portion of the bowel.

In many instances the final attack has been preceded by slighter ones. At first they attract but little attention: the narrowed part is blocked by some undigested food or fæcal mass which soon gives way; constipation and colic last for a time, and then there is a certain amount of diarrhœa. Later, as the constriction grows tighter, these attacks become more frequent and last longer; and, at length, in one of them the closure is final and the obstruction complete.

The pain is intermittent at the first, with long pauses between. As the passage becomes narrower the paroxysms grow more severe and the intervals shorter, until at last there is a continuous griping all over the abdomen, with every now and then violent storms of colic. There is no collapse until near the end. It is due to peritonitis or exhaustion, not to the injury inflicted upon the bowel. Vomiting, in the same way, is caused by the accumulation of food, or the action of purgatives, and may not appear for weeks; the time when it does occur depends chiefly upon the distance of the obstruction from the pylorus. Constipation is absolute, although the rectum may be emptied. Meteorism is very marked, especially if the obstruction is low down; the walls of the abdomen gradually become thin and stretch before the increasing pressure, and the coils of intestine, enlarged and hypertrophied from the increased amount of work, are visible, in many cases, on the surface of the abdomen, especially during the attacks of colic.

In spite of this difference it is impossible, in many cases, to draw a definite line between obstruction and strangulation. Sometimes, as in impacted gall-stones, the first closure is final and the symptoms intensely acute; or in true intestinal strangulation, slight attacks of a similar character have occurred previously and been mistaken for colic; or, again, intestinal strangulation suddenly happens to a patient who is already suffering from chronic constipation. The distinction that is wanted is a clinical one; the pathological data are fairly clear, but as yet it does not seem possible to place them in definite association with the symptoms.

Causes.—(1) Narrowing of the lumen of the bowel, whether due to stricture, compression from the outside, or to looping, bending or twisting of the bowel itself. (2) Loss of muscular power and accumulation of fæces. (3) Chronic intussusception.

1. Of these by far the most common is *stricture*, originating in the mucous or submucous layers of the bowel, and caused usually by cicatricial tissue or by carcinoma.

Simple stricture is occasionally met with in the small intestine, and then it may be multiple; in the large, in which it is nearly always single, it is infinitely more common. Upwards of one-half occur in the region of the sigmoid flexure; from this they gradually become more rare as the cæcum is reached, although stricture of the hepatic flexure is slightly more common than that of the transverse colon. In the small intestine it is most frequent towards the lower end; occasionally it involves the ileo-cæcal valve.

In most cases the cause of the ulceration has disappeared; there is nothing either in the shape or character of the cicatrix to lead to any conclusion. Of the rest a large proportion is due either to dysentery or tubercle. The former leaves behind it exceedingly irregular cicatrices, very often involving a large extent of bowel, and so hard and dense, and associated with so much contraction that, according to Treves, not improbably some of the cases of reputed scirrhus are really due to this. The latter is more common in the ileum, where it may either spread in a longitudinal direction producing little effect, or around the bowel transversely, in which case, if it cicatrises, it leaves an annular stricture, rarely very tight. Ulceration following catarrh, or due to the irritation of long-retained fæces (stercoral), is not uncommon in the large intestine, esepcially in the cæcum. Syphilis, in all probability, accounts for a few; and stricture is said to have been caused by the peptic ulcers that are occasionally found in the first part of the duodenum, and even by those that occur in typhoid fever.

Stricture of the small intestine sometimes follows blows and severe contusions of the wall of the abdomen, and may occur after the reduction of strangulated hernia, owing to the injury sustained by the mucous membrane.

Malignant stricture may be either primary or secondary; the former is probably always due to columnar epithelioma; the latter naturally depends upon the character of the original growth.

Columnar epithelioma generally occurs as an annular constriction, the growth following the course of the vessels; much more rarely in the form of nodules or flattened plaques. The stricture is always short and narrow: from the outside it seems almost as if a piece of string had been tied around the gut. The peritoneum is usually thickened and sometimes is adherent; the rest of the structures disappear; there is merely an irregular ulcer extending transversely around the interior of the bowel, with its base and sides hardened and infiltrated by the new deposit. Very often the diameter is so small that it scarcely admits a goose-quill.

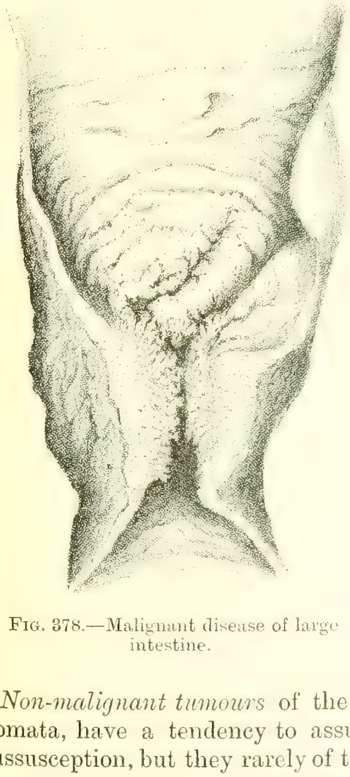

FIG. 378.—Malignant disease of large intestine.

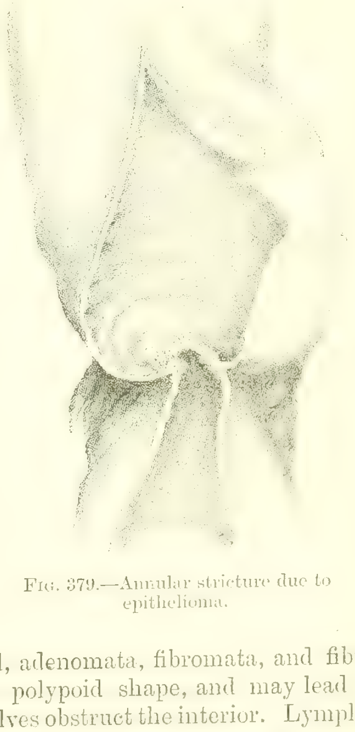

FIG. 379.—Annular stricture due to epithelioma.

Non-malignant tumours of the bowel, adenomata, fibromata, and fibromyomata, have a tendency to assume a polypoid shape, and may lead to intussusception, but they rarely of themselves obstruct the interior. Lymphosarcoma sometimes causes immense thickening of the wall, but seldom gives rise to any symptoms.

Compression.—The rectum, the sigmoid flexure, and the lower part of the ileum (especially those coils which hang down into the cavity of the pelvis) may be compressed by tumours growing from the walls of the abdomen or connected with the other viscera. In some cases the symptoms are acute; in twelve out of twenty-two collected by Treves the patient died before the ninth day (in one on the second); the bowel was suddenly caught in some way, or bent upon itself, and though the pain and collapse were scarcely so marked or so severe as in strangulation by bands, the points of difference were not sufficient to make the diagnosis certain. In the others the course was chronic, sometimes resembling that of stricture with intermittent colic, sometimes presenting nothing but increasing constipation.

In most cases this compression is effected by a tumour growing from the pelvis, or connected with the pelvic organs, the retroverted uterus, for example, and uterine or ovarian tumours; but it has been caused by vesical calculus, abscesses connected with the bones or the viscera, extra-uterine fœtation, tumours of the kidney or pancreas, floating kidney, hydatid cysts, and even by an enlarged and displaced spleen.

Compression may also be caused by peritoneal adhesions, especially at the hepatic and splenic flexures of the colon. In some cases the peritonitis may be due to fæcal accumulation; in others it spreads from the liver, gall-bladder, or other neighbouring structures; in others, again, it follows ulceration of the mucous membrane, and the cicatricial stricture inside the bowel is made worse by the peritoneal thickening around it. Whatever may be the cause, the bowel becomes narrowed; the walls become hard and dense, and a stricture is formed which cannot be distinguished by any of its symptoms from that which is due to dysentery or malignant disease.

Matting together of the intestine after operations for strangulated hernia, or ovarian tumours, pelvic or tubercular peritonitis, bending of the bowel, forming a valve in the interior, or limited adhesions impeding the peristaltic action of one segment, may all, according to Treves, give rise to the symptoms of chronic obstruction. Volvulus is nearly always acute; in one or two of the cases, however, in which the cæcum has been concerned, it has lasted some length of time, and the symptoms have resembled those of obstruction rather than strangulation.

Obstruction by gall-stones and foreign bodies resembles compression of the bowel in this, that while many of the cases are exceedingly acute others are chronic, the masses lying latent for years, and then, perhaps, causing symptoms of slow obstruction. Gall-stones find their way in by gradual ulceration, so that sometimes there is a history of previous peritonitis. Foreign bodies for the most part consist of materials swallowed in small quantities from time to time and worked up into solid masses with mucus or vegetable fibre. Pins, cherry-stones, cocoanut-fibre, yarn, and many other substances have been met with on various occasions, rolled up into enormous masses. Concretions, composed of carbonate of magnesia (taken as medicine), phosphate of lime and magnesia, and other indigestible substances mixed together are more rare, but occasionally attain an enormous size.

2. *Loss of power in the muscular fibre of the intestine and accumulation of fæces.* This rarely happens in the small intestine, but is not uncommon in the large, especially in the cæcum, transverse colon, and sigmoid flexure. The causes are very various—want of exercise, hysteria, chronic catarrh of the mucous membrane, hereditary influence, in short, anything that tends to impair the activity of the peristalsis. As a result the fæces collect and become hard and solid, the bowel below contracts, that above becomes distended; at length, the muscular fibres, already too weak for their work, are

stretched until they are not able to contract at all, and the passage is completely obstructed (*ileus paralyticus*). In many of the cases, as mentioned already, chronic peritonitis sets in and increases the difficulty by the thickening of the serous coat that it causes; in others ulceration of the mucous membrane occurs in the bowel above, and even if the obstruction is removed in time to prevent perforation, the subsequent cicatrisation may lead to the formation of a true stricture.

3. *Chronic intussusception* is a term applied somewhat arbitrarily to cases that have lasted longer than a month. It is classed with chronic obstruction more as a matter of convenience than because of the symptoms, for these are of the most indefinite and irregular character.

Pathological effects.—The consequences of obstruction are, speaking generally, the same as those that occur elsewhere in the body under similar conditions—dilatation and hypertrophy; but, from anatomical reasons, and because of the nature of the contents, they differ considerably in their importance.

Where the difficulty has arisen slowly, the coils of bowel, especially in the case of the small intestine, sometimes become of immense thickness, so that during the attacks of colic, when they are seen through the abdominal wall, they may be mistaken for the transverse colon. The distension is greatest immediately above the obstruction; the splenic flexure, for example, may be as large as the stomach, and the sigmoid one may stretch right over the other side of the abdomen; the mucous membrane becomes exceedingly thin; stercoral ulcers make their appearance, and sometimes, partly from the compression of the blood-vessels, partly from the irritation of the retained fæces, extensive tracts become gangrenous. In the case of the large intestine the ulceration is most marked immediately above the obstruction, and in the cæcum, where, if the ilio-cæcal valve is competent, the pressure is greatest; the intermediate portions may be quite intact, or the whole surface may be more or less involved. Perforation is not uncommon, leading to fæcal extravasation and general peritonitis; in some exceptional cases the extra-peritoneal portion of the bowel gives way, or adhesions form between two neighbouring coils, so that a fistula is established and this result avoided.

Causes of death.—Death may ensue in various ways at any time in the course of chronic intestinal obstruction. Perforation, for example, may take place suddenly, and lead to fæcal extravasation; the stricture may become blocked by a mass of fæces, or some foreign body, or it may be covered in by a fold of mucous membrane; volvulus or acute bending may occur; or the bowel above may gradually become so dilated that the pressure alone is sufficient to close the opening, and the symptoms suddenly, from one hour to another, become acute, resembling, but rarely quite so severe as, those of strangulation. In other cases, especially where there is malignant disease, the stricture gradually grows so narrow that at last the patient dies, worn out and emaciated by the long-continued trouble. Very narrow strictures may exist for a long time in the small intestine without causing any symptoms, owing to the liquid character of the contents, and occasionally, but much more rarely, when there is persistent diarrhœa, this happens in the large.

Symptoms.—1. *In stricture, peritoneal adhesions, and compression*, the symptoms, so far as the obstruction is concerned, are essentially the same; the differential diagnosis is often impossible, except from the history and age of the patient, from the presence of a tumour or some other additional evidence, and the locality is in many cases equally uncertain.

Colic, *constipation*, and *distension* of the abdomen are nearly always present. In a typical case the attacks at first are intermittent, with intervals of comparative comfort; but as the constriction becomes narrower, they grow more and more frequent until at length, when the obstruction is complete, they never really cease, although they are worse every now and then. Sometimes they occur suddenly in patients who are perfectly well to all appearance; more often they are preceded by dyspepsia, diarrhœa or constipation. In a few rare cases there is only one, the bowel becomes kinked, or the narrowed portion is blocked for the first and last time, and the symptoms are those of strangulation. In most cases the onset is insidious, and the first attacks slight, merely regarded as indigestion; only as the case progresses do they become definitely associated with vomiting and constipation.

Pain.—As a rule nothing can be gathered from the locality of the pain; as often as not it is referred at first to the umbilicus, but it soon becomes general, and it rarely happens that the patient is able to describe it as beginning and ending at any definite spot. It is due to violent peristalsis, and is always griping, even when it is continuous; the coils, which are nearly always visible through the wall of the abdomen, working over and over each other. Food, enemata, and even digital examination of the rectum, may bring on an attack. Sometimes towards the end it becomes less severe, probably from the muscular and nervous mechanism of the bowel becoming exhausted.

The pain is generally more acute when the seat of obstruction is in the small intestine; in this case it is often traceable to the food, coming on at regular intervals after meals, and it may be relieved by aperients, which when the colon is concerned merely aggravate it.

Constipation is the rule. During the attacks of colic it is always present, and as they pass off is often followed by diarrhœa. In the small intestine, where the contents are liquid, it may not appear until comparatively late; and, until the constriction is very tight, it can generally be relieved by aperients. When the colon or the sigmoid flexure, on the other hand, is involved, there may be a certain amount of spurious diarrhœa for a time, similar to that which is often present in fæcal accumulation, kept up by the irritation of the mucous membrane; but always at length the obstruction becomes complete, and sometimes no motion is passed for weeks before death. A single copious motion after prolonged obstruction is, according to Treves, often significant of perforation.

Meteorism.—The distension of the abdomen depends upon the seat of obstruction and the amount of diarrhœa; when the constriction is high up it may be altogether wanting, except, perhaps, during the attacks of colic, and in some cases there is retraction instead, owing to the emaciation. On the other hand, in stricture of the sigmoid flexure, the enlargement may be immense, the diaphragm being pushed up into the thorax, displacing the heart, and seriously impeding respiration. During the attacks of colic, and if peritonitis sets in, the walls become tense and tender; at other times they are soft, so that when the coils of bowel are distended with fæces and flatus they may be felt as well as seen through them.

Vomiting, unless the obstruction suddenly becomes acute, is not a prominent symptom. Its occurrence and severity depend upon the seat of obstruction and the amount of food; when the stricture is near the pylorus it rarely fails to make its appearance early in the attacks of colic, and may be very profuse; when it is in the large intestine and the food is carefully selected, it may not occur for weeks, and it rarely becomes fæcal until complete obstruction has lasted for some time. Other symptoms, which may be of help in diagnosis, are occasionally present. Tenesmus only occurs in stricture of the large intestine, and is rare even then. In carcinoma of the sigmoid flexure there is not unfrequently a thin blood-stained discharge from the anus, especially in the intervals between the attacks of obstruction. Sometimes a tumour can be felt, either *per rectum* or through the abdominal wall, but rarely when the small intestine is concerned. Masses of fæces can occasionally be felt in the cæcum or the transverse colon, and this may be stretched and displaced so far as to reach the symphysis. The outline of the colon may be seen, or there may be dulness on percussion along some part of its course—in one flank, for example, and not in the other—and in some few cases valuable information may be obtained by means of enemata, or by the introduction of the hand into the rectum.

2. *Obstruction due to fæcal accumulation* rarely occurs until comparatively late in adult life, and is more common in women than in men. Not unfrequently it is associated with hysteria or hypochondriasis, and nearly always there is a history of chronic constipation for years past; the bowels have only acted at long intervals and after aperients or enemata, and the motions have been copious and exceedingly hard. In other cases the patient complains of persistent diarrhœa with thin watery stools; the mucous membrane of the bowel is irritated by hard scybalous masses, and the secretion mixed with the liquid portion of the fæces is constantly flowing down into the rectum.

The symptoms are essentially the same as those of stricture of the large intestine, only they are as a rule more chronic; in rare instances there is a sudden acute attack with prostration and vomiting, probably due to the bowel becoming bent or twisted upon itself in some way, or to atony of the muscular wall. The patient is a martyr to dyspepsia; the tongue is foul; the appetite poor; the breath exceedingly offensive, and there are constant attacks of flatulence with distension and severe griping pain and nausea. The abdomen is large and resistant; fæcal masses may often be felt through its walls, sometimes in the cæcum, lying in the right iliac fossa, more often in the transverse colon or the sigmoid flexure. Tumours of considerable size are occasionally formed in this way, but their nature may almost always be made out from their mobility, variable shape, and doughy consistence. The diaphragm is pushed up, causing palpitation and interfering with respiration; the portal circulation is obstructed so that hæmorrhoids result; sometimes the uterine, spermatic, or iliac veins are affected as well; and the patient loses flesh and strength and not unfrequently becomes hypochondriacal. In many instances this condition persists for years, relieved from time to time by aperients and enemata, but there is always the danger that sooner or later the muscular power of the bowel may fail, or the distension above increase, until at length ulceration and perforation occur.

3. *Chronic intussusception* is exceedingly variable in its course. It is rare in children, and is nearly confined to the large intestine. The onset is usually sudden; in most instances a tumour can be felt through the abdominal wall, or *per rectum*, and the coils of small intestine can often be seen, especially

during the attacks of colic. Vomiting may occur, but it is not urgent like that of strangulation; tenesmus and a discharge of blood-stained mucus are rarely absent; sometimes there is constipation, but more frequently a kind of spurious diarrhœa. The pain is seldom severe, except during the attacks of colic, when all the symptoms become intensified. This condition has been known to continue with fluctuations for months; as a rule, after it has lasted some length of time, either the bowel becomes strangulated or the patient becomes exhausted from the prolonged suffering and want of food, grows thinner and thinner, and succumbs at last rather suddenly.

Diagnosis.—The diagnosis of intestinal obstruction is always a matter of the greatest difficulty, and in most instances the examination of the abdomen has to be repeated time after time, during the attacks of colic as well as during the intervals, with an anæsthetic as well as without, before a definite opinion can be given.

1. *The previous history of the patient.*—In stricture and fæcal obstruction there is generally a record of previous slight attacks of a similar character, yielding at first easily to remedies and gradually becoming more severe; constipation has often continued for a time, and then given way to diarrhœa; and the patient has been distressed, and the action of the bowels and the digestion disordered, for some considerable period. Scybalous masses passed from time to time, and habitual constipation for years before, point rather to the latter, though it must not be forgotten that this may be merely a complication; a blood-stained discharge from the anus is suggestive either of malignant stricture low down or of chronic intussusception.

Antecedent attacks of local peritonitis or typhlitis; strangulation of a hernia some months before; injuries to or operations on the abdomen; hepatic colic, dysentery, gastric ulcer, or any other intestinal trouble; or the history of an abdominal tumour, may be of very great significance. Rapid wasting, without sufficient apparent cause, is suggestive either of tuberculosis or of malignant disease; but a certain degree of emaciation is always present in chronic obstruction, and if the case has lasted any time it may be very distinct.

2. *The mode of onset of the present attack and the order of appearance and severity of each of the symptoms.*—If it commences suddenly and the vomiting and prostration are serious from the first, it must be regarded as a case of intestinal strangulation. Pathologically the actual cause may be a gall-stone or some other obstructing agent; the symptoms are those of strangulation and must be met in the same way before it is too late.

If it is gradual, each symptom must be taken in order. First the pain, whether it is griping as in colic, and whether the paroxysms are becoming more frequent, showing that the obstruction is growing tighter. If it occurs a short time after taking food and is relieved by aperients it is probably due to stricture of the small intestine; if it is continuous, the obstruction is complete; if it is made worse by digital examination of the rectum or by enemata, it is most likely in the large intestine; and if it is distinctly localised, or if it always ends at one spot, it may point to the seat of obstruction, but this is exceptional. The state of the bowels is of equal importance; constipation may be complete, both as regards fæces and flatus; or there may be a certain amount of diarrhœa as in fæcal accumulation; and blood and mucus may be passed at frequent intervals with tenesmus, as in chronic intussusception. Vomiting is rarely of much help; unless the attack is acute, so that it is excited by the injury to the nerves of the bowel, it does not come on until late, and it depends chiefly upon the amount and kind of food. Stricture of the small intestine high up is an exception, as in this vomiting is one of the earliest symptoms. It seldom becomes stercoraceous until the obstruction is of some standing. The amount of urine may be diminished, but this as a rule depends upon the small quantity of fluid taken, not, as in strangulation, upon the presence of collapse.

3. *Physical examination. Inspection.*—The attitude of the patient is generally such as to relieve the abdominal muscles as much as possible. The abdomen may be immensely and unevenly distended or retracted, according to the seat of obstruction and the degree of emaciation. The walls are always thin, sometimes tense and stretched, and in nearly every case the coils of intestine can be seen working through them, especially during the paroxysms of colic. Respiration is usually shallow and thoracic. There may be hiccough, especially in advanced cases, and under the same circumstances, when collapse is approaching, there may be vomiting without effort, coming up in gushes as in strangulation. Everything that is brought up or that is passed *per anum* must be carefully examined.

Palpation.—The first thing is to exclude all forms of hernia: every aperture through which one could take place must be carefully examined. Then the state of the walls and the presence of any tenderness must be noted. During the attacks of colic the muscles become rigid and the skin is very tender to the touch; in the intervals this disappears to a great extent unless there is some inflammation, such as perityphilitis or peritonitis, or a tumour of rapid formation, as in intussusception. Finally, if the condition of the abdomen and of the patient allows it, the surface must be gently kneaded to ascertain if there is any sense of resistance in one part more than in another, or if any sign of a tumour can be found. Fæcal masses are usually nodular in shape, moderately hard and uneven; generally speaking they are movable, but this depends, of course, upon the portion of intestine in which they are contained; sometimes the transverse colon reaches down as low as the pubic symphysis, and the masses can be pushed up nearly to the ensiform cartilage. Examination of the patient in various positions—the knee and elbow, for example—is often of service in diagnosis.

Percussion, although digital examination of the rectum should be regarded as part of palpation, follows next. It is rarely of much service, although one flank or one iliac fossa is occasionally much less resonant than the other.

Examination of the rectum should never be omitted; in young subjects in whom the perinæum is soft and yielding the anus may be pushed so far in, especially under an anæsthetic, that the finger can touch the promontory of the sacrum, and fæcal masses, stricture of the rectum, intussusception, and other conditions diagnosed. In the case of adults a moderately small hand can be introduced. I have on several occasions diagnosed new growths above the reach of the finger, and in one instance a mass of scybala in a loop of intestine; but probably the chief use of this method is as an aid to the long enema-tube. By itself this is almost worthless for diagnosis; but if it is guided in over the hand, so that it can be freed from the folds of the bowel, and its entrance into the sigmoid flexure assured, it can be passed without difficulty into the descending colon, beyond the point at which the bowel can be exposed in the loin.

The rectum and the lower part of the large intestine vary to such an extent in size that the amount of fluid which can be introduced gives no idea. If, however, the long tube is passed, the position of the end of it in the bowel can be made out with tolerable accuracy by means of auscultation.

There is no means of diagnosing cancerous stricture of the small or large intestine from chronic obstruction due to cicatrices, peritoneal adhesions, or compression. Carcinoma may occur in the intestine at twenty years of age, though it is much more common later in life, and the symptoms are practically the same; the emaciation is a little more rapid, diarrhœa is rather more common, especially at the beginning of the case, and in epithelioma of the large intestine a discharge of blood and mucus may occur; but there is nothing more definite on which a diagnosis can be based. The prognosis in cancerous stricture is rather longer than in the cicatricial form, so far as life is concerned, probably because, as Treves has pointed out, obstruction does not make its appearance so early.

Treatment.—1. *Chronic obstruction due to stricture, peritoneal adhesions, volvulus of the cæcum, compression, &c.*—So long as the closure is incomplete, relief may be obtained for a time by dieting and by laxatives and enemata. Vigorous purgatives do more harm than good by disturbing the orderly action of the intestine and hurrying down a mass of semi-digested material on to the face of the stricture. The object is to nourish the patient as well as possible without increasing the amount of indigestible material or rendering the fæces hard. In the small intestine this is tolerably easy for a time, and partly by restricting the diet to small quantities of liquid food given at long intervals, partly by nutrient enemata, the strength may be maintained for a considerable period, especially if it is economised by warmth and avoidance of exertion. When the large intestine is involved this is not so easy, but a great deal may be done at first by means of enemata of hot water with some alkali to soften the fæces and stimulate the walls of the bowel. Not unfrequently a stricture that has been made impermeable by the impaction of a mass of fæces in its orifice may be entered without difficulty from below and the intruding substance displaced and perhaps softened sufficiently to relieve the obstruction for the time.

Opium is invaluable for the relief of pain, as in acute cases, and prevents to a certain extent the severity of collapse, but it has little or no influence on any of the causes of obstruction mentioned above, and obscures the symptoms to such an extent that when it has been given full allowance must be made for it.

If the obstruction is complete, or if, in spite of all precautions, the abdomen is becoming more distended and the attacks of colic more frequent and more severe, it is of no use delaying further; if any operation is required it should be done before the patient is exhausted.

(*a*) *Where the seat of obstruction can be diagnosed.*—If it is in the small intestine the abdomen must be opened in the middle line, and the cause dealt with according to its nature and the condition of the patient. In some few cases relief may be obtained by dividing adhesions and so releasing the bowel, but in the majority the choice lies between enterostomy, short-circuiting with Senn's plates, and resection. Of these the former is more simple, and if a large extent of bowel is involved is the only one admissible; but it can, of course, only be regarded as a palliative, and is useless unless the seat of obstruction is low down in the ileum. Resection alone can give permanent relief, and the condition of the bowel and the strength of the patient must decide whether it should be performed at once or postponed until an artificial anus has been formed.

The rule is the same in the case of the large intestine: if the seat of obstruction is known the bowel should be opened at the most convenient spot above; or, if it is a malignant stricture, an attempt may be made to excise it, and either form an artificial anus or suture the two ends together, according to circumstances. Compression by external tumours is an exception: in these cases special treatment is required.

(*b*) *Where an exact diagnosis cannot be made.*—If the situation is entirely unknown, median laparotomy must be performed as an exploratory measure, and the obstruction dealt with according to what is found. The colon or cæcum may.be opened and stitched to the skin, or the wound closed and colotomy performed later on. When, however, the balance of evidence points distinctly to the large intestine without the exact site being indicated, the colon should be opened in the right loin or in the right iliac region. If the bowel is found not to be distended, temporary relief may be obtained by opening the nearest and most prominent loop of small intestine.

2. *Fæcal accumulation with loss of power of the wall of the intestine.*—Unless acute symptoms, such as vomiting and prostration, indicative of ileus, set in, this should be treated with laxatives and enemata. Lumbar colotomy must be regarded, according to Treves, rather as a surgical misfortune than as a recognised method of treatment.

A siphon apparatus is better than a syringe, as the pressure is more uniform. The patient should be placed so that the abdominal muscles are relaxed as far as possible, and warm water with soap or oil allowed to flow in gently until by degrees the whole of the colon has been washed out. It may be cleared thoroughly as far as the cæcum; there is no fear during life of any quantity of fluid passed beyond. A little turpentine may be used if a more stimulating injection is required.[1] Massage, kneading the abdomen in the course of the colon, and electricity are sometimes of benefit in these cases. The faradic current is used and one pole is placed on the abdomen or the dorsal spine, the other, properly insulated, in the rectum.

3. *Chronic intussusception.*—Here, as in the acute form, opium should be given at once to check the increase of the invagination, and to delay the onset of strangulation and inflammation. Then an attempt must be made to reduce the bowel by means of enemata given with great care and combined with massage under an anæsthetic. Reduction has taken place even at the end of a month, but, as Treves has shown, adhesions, as a rule, very soon make their appearance in cases that are left to themselves. If enemata fail, the only course left is laparotomy, and if reduction cannot be effected then, either resection, short-circuiting, or the formation of an artificial anus.

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[1] Hutchinson's description of massage of the abdomen in cases of intestinal obstruction is as follows: 'The first point in abdominal taxis is the full use of an anæsthetic, so as to obliterate all muscular resistance. Next (the rectum and bladder being supposed to be empty), the surgeon will forcibly and repeatedly knead the abdomen, pressing its contents vigorously upwards, downwards, and from side to side. The patient is now to be turned on to his abdomen and in this position held up by four strong men and shaken backwards and forwards. This done, the trunk is to be held, feet uppermost, and shaking again practised directly upwards and downwards. Whilst in this position copious enemata are to be given. The whole proceedings are to be carried out in a *bonâ fide* manner. Half-an-hour or more is to be spent in the process.

SECTION V.—PERITYPHLITIS; PERITONITIS

PERITYPHLITIS

INFLAMMATION of the cæcum and appendix is common in young adults, especially males. It may be simple or suppurative. The former merely leads to thickening and condensation of the tissues around; the latter ends either in a perityphlitic abscess or in general peritonitis. Suppuration may begin outside the bowel, in the inflammatory exudation (forming sometimes a secondary communication with the intestine); but, probably, in most cases, it is the result of perforation (nearly always of the appendix), especially when its onset is instantaneous, without any warning.

Causes.—The simple form, like colitis, usually arises from the accumulation of scybala, and remains limited to the mucous surface. Occasionally the inflammation is more severe, involving the whole thickness of the wall, and then the serous covering becomes affected.

The perforative form may be due to ulceration (the stercoral ulcers of old intestinal obstruction, or those resulting from tubercle, syphilis, or dysentery, for example); to the presence of foreign bodies, such as fish-bones; or to the appendix becoming blocked. When this occurs, whether it is due to cherry-stones, dried fæces, the presence of adhesions, or any other cause, the secretion accumulates, the tension grows higher and higher, inflammation sets in, and, unless the obstruction gives way, ulceration follows and ends in perforation.

Cases in which the appendix is blocked and the obstruction yields from time to time without actual perforation taking place, are sometimes distinguished as relapsing typhlitis.

(*a*) *Simple perityphlitis.*—This usually occurs in young adults who are subject to chronic constipation. They may even have passed scybalous masses or have suffered from attacks of diarrhœa (colitis) excited by them. It commences quietly without a rigor, and generally with little fever. Almost from the first there is a hard doughy tumour in the groin. The abdominal muscles are rigid and tense, and pressure causes such pain that it is rarely possible to make out the outline without an anæsthetic. Vomiting is not severe or continuous, and examination *per rectum* does not reveal any marked thickening. Very often there is a history of numberless minor attacks (whenever indeed the patient's bowels are confined), none of which has been sufficiently severe to lead him to seek advice. As a rule cases of this kind are not seen by the surgeon at all; they may last a week or ten days and cause justifiable alarm, but nearly always the symptoms disappear under low diet, opium and enemata. Probably, in the more severe cases, the peritoneum is always involved, as it is not unfrequent to find *post mortem* the appendix firmly tied down by adhesions.

(*b*) *Perforative perityphlitis.*—This may commence in the same way, slowly and insidiously, but, as a rule, the symptoms are much more acute. Often there is no warning of any kind, and no history of constipation or digestive trouble. Quite suddenly the patient is seized with intense pain in the groin, shooting down the thigh, or into the testis and the perinæum.

Vomiting comes on almost at once; the abdomen begins to swell and become tympanitic, and all the symptoms of acute localised peritonitis are developed within a few hours. The face and the pulse change, the urine is scanty, the temperature rises, and the respiration becomes shallow and hurried. Very often no abdominal tumour can be detected; the general tympanites obscures everything, but usually an ill-defined fulness can be made out through the rectum.

In other cases the illness is of longer duration. There is a history of repeated trouble, without, however, the attacks bearing any relation to the condition of the bowels. Rigors are not uncommon; the temperature is high and very irregular; a certain amount of fulness, sometimes definitely limited, can be felt in the groin; occasionally there is some œdema of the skin, and circumscribed inflammatory induration can nearly always be felt through the rectum. In most of these there is a localised abscess communicating with the appendix through the floor of an ulcer. Its walls are usually fairly thick and formed of the surrounding structures welded together by adhesions; but each attack means an extension in some direction. The pus may at length work its way out through the anterior abdominal wall and point in the groin or the thigh, or it may burst into one of the neighbouring viscera, or discharge itself over the crest of the ilium, into the hip-joint, and even through the diaphragm; but each time there is always the danger of the peritoneum suddenly giving way (it has happened as a result of manipulation) and of diffuse peritonitis following.

Finally, a certain number of cases have been described as *relapsing typhlitis*. They are characterised by a succession of attacks scarcely less severe than those that are present in the perforative form; but though sometimes a tumour can be detected through the rectum, there is nothing but indefinite induration to be felt in the iliac fossa. In one of these (a patient who had suffered from fourteen severe recurrences in eighteen months, and was reduced to the condition of a hopeless invalid), Treves found the appendix bent upon itself and immensely dilated; and in another it was of enormous size, tied down by adhesions, and on the point of giving way. Probably a similar condition furnishes the starting-point of some of those cases of perforative perityphlitis in which suppuration is localised. So long as the appendix is able to discharge its contents from time to time, the pain and inflammation are only of moderate intensity, and the surrounding tissues become thickened and adherent; if it becomes completely blocked ulceration sets in, perforation follows, the appendix becomes gangrenous, and an abscess with very irregular walls is left.

Treatment.—Perforative perityphlitis, if left to itself, may end in the abscess gradually working its way towards the surface, causing more or less serious destruction, or it may lead to sudden and diffuse peritonitis. This danger is always present, but when the symptoms are acute and the attacks frequent it is imminent. Immediate operation is advisable if signs of perforation have suddenly appeared in a person previously healthy; if there is evidence of acute suppuration (rigors, and an evening rise of temperature with great tenderness and perhaps œdema), particularly if it is spreading; or if there is any indication of a chronic abscess working its way onwards. Further, it is certainly to be recommended in cases of relapsing typhlitis in which, from the severity and constant repetition of the attacks, it is clear that the appendix is seriously involved.

Aspiration through the wall of the abdomen has been strongly recommended, but the chances of hitting off a small collection of pus are very slight, and the risk is certainly not trivial.

The incision, unless there is some distinct indication elsewhere, should be parallel to and slightly above Poupart's ligament, almost that for ligature of the external iliac. The median is too far, and the advantages of the linea semilunaris are very doubtful. Great care is needed when the peritoneum is reached. It must be divided freely, the intestine exposed, and the matted coils carefully separated from each other with the fingers working down in the direction of the cæcum and preventing any of the healthy bowel coming near the disease. If pus is found it must be dealt with according to circumstances; it may be possible in a chronic case to sponge out the cavity and expose the appendix, and sometimes this may be removed and the cut edges inverted and secured with sutures, but usually the adhesions are much too delicate to stand such manipulation, and all that can be done is to provide free exit for the pus by means of a drainage-tube, in the hope that the surrounding tissues will adhere and protect themselves. If the operation is performed for relapsing typhlitis a quiet interval, when there is no acute inflammation, should be selected, and the margins of the opening made when the appendix is removed may be inverted and stitched together. In these cases, as pointed out by Treves, the external incision should commence over healthy tissues, so that the condition of the diseased part may be made out from the serous cavity; otherwise it may be impossible, owing to the presence of adhesions, to ascertain the relative position of the various structures; the appendix or the cæcum may even be adherent to the anterior wall. Care must be taken not to mistake the ureter for the appendix.

PERITONITIS

Inflammation of the peritoneum is peculiar in many respects. The surface of the cavity is of enormous size (scarcely less than that of the skin), it possesses the most remarkable power of absorption (so that fluids of all kinds, poisonous or not, disappear with very great rapidity), and if one part is infected, owing to the constant movement of its contents and the freedom of communication between all its cavities, the inflammation is very likely to involve the whole.

Causes.—Peritonitis may be caused by unorganised irritants (chemical or mechanical); or by living organisms (specific or non-specific). Further, it may arise by direct extension from the structures that lie adjacent to it, the walls of the intestine or of the abdomen.

(*a*) Simple mechanical irritation produces but a very limited effect. In an old hernia, for example, the neck of the sac and the serous coat of the intestine that slips into it (if it is always the same piece), gradually become thickened, hard, and dense from organisation of the inflammatory exudation.

Chemical irritants vary more in their effect: some are absorbed at once, and merely give rise to constitutional symptoms, depending upon their nature and amount (such, for example, is one form of septicæmia following abdominal operations, in which the patient becomes cold and collapsed and dies within forty-eight hours from acute blood-poisoning, without any visible sign of peritonitis). Others irritate the surface, so that exudation takes place instead of absorption. In this case the future course depends upon the surrounding conditions: if the injury is very extensive death may occur from shock; if less severe the lymph that is poured out around the affected area either becomes organised, or, if pyogenic irritants gain access to it, breaks down into pus.

(*b*) Organic irritants may be either specific or non-specific. The tubercle-bacillus is by far the best known example of the former, and tubercular peritonitis will be dealt with separately. Syphilitic peritonitis rarely occurs, except as a result of extension from neighbouring organs, such as the liver, and presents no special features.

The non-specific organisms may be pyogenic or not. Of these the latter are not capable of causing peritonitis so long as the surface of the membrane is uninjured; if, for example, putrid fluid, containing only the organisms of putrefaction, is injected into the uninjured peritoneal cavity, death will ensue from septicæmia if the quantity is large enough, but if it is only small the whole may disappear without exciting any local irritation. The constitutional effect depends entirely upon the dose, and it is practically the same whether the fluid is injected into the blood-stream at once, or allowed to find its way in through the peritoneal cavity, and it follows nearly as quickly in the one case as in the other.

Even the pyogenic organisms, according to Grawitz, can only cause peritonitis under special conditions: when, that is to say, the amount of fluid injected with them or poured out by the injured surface is so great that the germs are produced more rapidly than the tissues can deal with them; or when the surface of the peritoneum is injured and the subepithelioid layer exposed. In many instances the inflammation was found to have spread from the prick of the needle that had been used for the injection.

Unhappily these conditions are of common occurrence. Infected wounds, rupture of the viscera, perforation of the intestine, bursting of a hydatid cyst or of an abscess, and communication with a neighbouring cavity, such as the Fallopian tube in a case of metritis, present in abundance everything that is required for the development of acute suppurative peritonitis. There is a sufficient amount of nutrient fluid for the growth of the germs, or if there is not it is poured out at once by the irritated peritoneum; the epithelioid surface is injured over a wider or smaller area by the fluid that bathes it; absorption is checked, and myriads of pyogenic organisms can make their way in from the intestine, through the wound, or even through the blood-stream.

(*c*) Peritonitis due to extension from the parts around varies naturally with the primary cause; as a rule, it is protective in character, and leads to the formation of adhesions.

Whether cold can be regarded as a cause is uncertain; there can be no doubt, however, that it predisposes to it by lowering the vitality of the tissues and rendering them more susceptible.

Symptoms.—Clinically, peritonitis may be sthenic or asthenic in character. The latter occurs when the strength of the patient is overcome by septicæmia, typhoid fever, or Bright's disease.

In the sthenic form the symptoms are very striking. There may be a succession of chills or a rigor; the temperature rises at once; the pulse becomes peculiarly hard and rapid, and the respiration hurried and very shallow. The abdomen may be retracted at first, but very soon it begins to swell over the affected spot, and, in a short time, the whole becomes tense and hard, the muscles are absolutely rigid, the diaphragm is pushed up as far as it can go, and the least touch causes the most fearful pain. The patient lies on the back with the knees drawn up; the face becomes pinched and anxious, the eyes sunken, and the tongue dry and brown; vomiting with hiccough is very common, and usually the fluid is poured up in gushes almost without effort. Constipation is almost invariable, and the amount of urine secreted is very small. Towards the end the temperature may fall, and the patient sink into a state of collapse; sometimes this occurs almost with the first onset of the disease.

In the asthenic form the constitutional symptoms are more prominent. The abdomen may or may not be distended, sometimes it moves with respiration; pain is felt on pressure; but there is not the intense tenderness characteristic of the sthenic variety. The pulse is very small and weak, the temperature subnormal, and the collapse profound from the first. *Post mortem* there are no adhesions between the coils of intestine and no lymph on the serous surface, merely a small quantity of a turbid, intensely poisonous liquid.

Treatment.—It used to be the rule in every abdominal operation to give opium in order to keep the intestines quiet and prevent peritonitis. Now it is recognised that while opium is essential when the walls of the intestine have been injured, and is of great value in localising inflammation, it can do nothing to prevent it; indeed, by assisting the distension of the intestine, and still further impairing the muscular tone of its wall, it may actually intensify the evil it is intended to check. For this reason, Wylie, Tait, Greig Smith and others recommend a saline purge after abdominal operations if fluid is collecting in the pelvis, or if there is rapidly increasing distension of the abdomen, with restlessness and vomiting. The tympanites is an additional cause of obstruction and vomiting; opium only encourages it; a purge, on the other hand, followed by a turpentine or hot-water enema, will carry off immense quantities of gas and fluid, and relieve the congestion of the abdominal vessels. Afterwards the beneficial effect may be continued by the frequent use of the rectum-tube. The vomiting that is consequent upon an anæsthetic may be checked by allowing the patient to suck one or two small fragments of ice (not more); if it continues, particularly if there are other signs of peritonitis and the straining is very severe, a cupful of hot water is much more serviceable, and occasionally the stomach may be washed out with advantage.

If in spite of this the symptoms grow worse, or if it is clear from the first that it is a case of perforative peritonitis, the only hope lies in giving free exit to the poisonous fluid. It is true that the condition of the patient is almost desperate, and that shock is much more severe when the peritoneum is inflamed; but if the serous cavity is unable to deal with the poison that bathes its surface, steps must be taken first to prevent any more entering, and then to get rid of that which is already there.

Greig Smith recommends the injection among the intestines of boroglyceride solution, an ounce to the pint, at a temperature of 102° F. It should be slowly forced into the cavity among the intestines through a drainage-tube, and compelled to remain there for a time by temporarily plugging the orifice; and this may be repeated several times a day.

Mikulicz distinguishes between diffuse peritonitis, due to a large amount of the contents of the intestine being poured suddenly into the cavity, and a progressive form which is localised at first. The former can only be treated by a free opening and washing out the cavity with hot salt and water, or hot boracic solution, until it is thoroughly cleansed. The latter, on the other hand, may remain localised for a time, and if the situation of the successive foci can be made out, they may be opened and drained separately, taking great care not to disturb any of the adhesions. Thorough drainage of the peritoneal cavity is almost impossible, but the attempt has been tried by making numerous openings in the middle line and in the flanks, and by passing across as many as eight large perforated tubes through which a current of hot salt solution could be sent.

When the suppuration is localised already, the prospect is much more hopeful ; there are already many instances on record in which purulent collections, consequent on intestinal perforation, gonorrhœal inflammation, and other causes have been successfully drained.

TUBERCULAR PERITONITIS

A large number of cases of encysted tubercular peritonitis have been relieved and not a few cured by free incision. Even when the disease is part of a general tuberculosis a certain amount of benefit may be obtained without in any way hastening its progress. In the earlier cases the diagnosis was not made until the cavity had been incised, and from the extreme difficulty of distinguishing between some of these forms of encysted ascites and ovarian and other cysts, the same mistake is not unlikely to occur again. In a fair proportion of cases the diagnosis has been verified by the microscopic examination of the miliary growths and the discovery of bacilli.

Primary peritoneal tuberculosis (the class of disease for which operation is most suitable), is probably not common ; nearly always it is secondary, but as there is evidence to show that the partial removal of tubercular foci in other parts of the body is sometimes beneficial, the patient appearing to make better headway against the rest, and as considerable relief may not unreasonably be expected to follow the removal of a mass of this character from the abdominal cavity, operation is not negatived by this, provided the disease is not too far advanced. Whether anything more than simple drainage is advisable is uncertain ; probably it would depend to a large extent upon the size of the cavity and the character of its walls.

SECTION VI.—OPERATIONS ON THE INTESTINES

ENTEROSTOMY

THIS is sometimes known as Nélaton's operation. A small incision is made in the abdominal wall, an inch and a half or two inches in length according to the thickness ; the peritoneum is incised, and the most distended loop of small intestine that lies near is drawn into the wound and fixed with sutures.

If the case is urgent and the bowel must be opened at once, very accurate and very firm adaptation is necessary, as in such cases there may be a considerable amount of movement as soon as the pressure is relieved. The parietal peritoneum may be drawn outwards and fixed to the skin by two or three sutures; and then four, or better six, silk threads must be passed through the united layers, the visceral peritoneum, and the outer coats of the bowel. One or two catgut sutures may be used between the others for greater accuracy. The opening in the intestine should be merely a puncture. Escape of the contents may be best prevented by covering the edges of the wound with an antiseptic ointment and using the aspirator.

Where it is possible, it is advisable to divide the operation into two stages, stitching the bowel into position first; and two or three days later, when adhesions have formed between the peritoneal surfaces, making the opening into it, and if necessary securing it by further sutures.

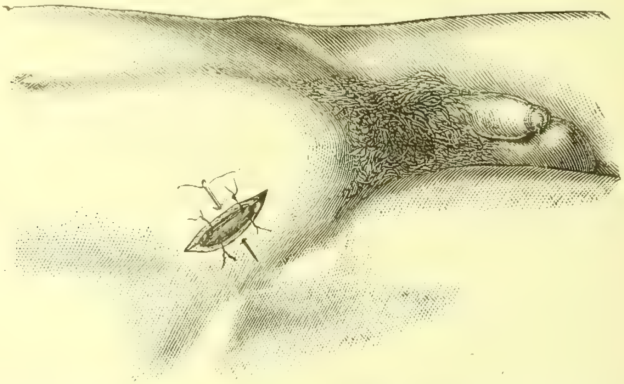


FIG. 380.—Inguinal wound made in Nélaton's 'Operation of Enterotomy.'

As originally performed by Nélaton, the operation was in the right iliac fossa, between the deep epigastric artery and the anterior superior spine of the ilium; and the portion of bowel opened was the small intestine immediately above the cæcum. It may be done, however, in the middle line or in the right lumbar region, if it is found when the colon is exposed that the seat of obstruction is higher up.

As a primary operation enterostomy meets with but little favour. The cases of obstruction in which distension of the bowel is the only cause are very few in number; these may be cured by such an operation, and the opening closed. It is, however, as yet impossible to diagnose them from other forms of intestinal strangulation in which the operation, if it were performed, would merely give momentary relief, leaving the real source of the mischief untouched. On the other hand, when the colon has been exposed and found empty, or when laparotomy has been performed and some hopeless condition discovered—an irreducible and extensive intussusception, for example—or widely spread carcinoma in a patient who is completely exhausted, enterostomy may prove of the greatest service by relieving distension and pain and prolonging life.

Greig Smith recommends that in cases of intestinal obstruction in which the patient is much collapsed, this operation should be performed under local anæsthesia by the subcutaneous injection of cocaine, merely to give time to rally. Even if nothing is given the pain of the incision is scarcely felt, and any other anæsthetic, increasing the depression or causing vomiting, would almost certainly extinguish the little chance that is left.

COLOTOMY

The colon may be opened either in the lumbar region on the right or left side, or in the left inguinal. In the former operation, which was first performed by Amussat on the right side, the posterior surface of the bowel where it is uncovered by peritoneum is, generally speaking, exposed ; in the latter (Littre's) the peritoneal cavity is always opened.

LUMBAR COLOTOMY

The colon is placed half an inch behind the middle of the crest of the ilium, as measured between the anterior and posterior superior spines, lying upon the quadratus lumborum, immediately below the kidney. If it is distended there is usually a considerable surface uncovered by peritoneum ; when it is collapsed this contracts ; but the sides may generally be separated from each other, and the bowel reached without interfering with the serous surface. In a certain proportion of cases, however, a mesocolon is present, especially on the left side (Treves), and then it is impossible.

The patient is placed on the opposite side, almost semi-prone, with a hard round pillow under the loin to separate the last rib from the ilium. The margin of the erector spinæ is defined, and an incision, two and a half to three inches in length, is made obliquely upwards and backwards towards the angle enclosed by the last rib and the spine. The middle of it should correspond to the spot at which it is expected the bowel will be found. Practically, unless the last rib is much depressed, the incision is parallel to it and the arteries, and lies in one of the natural folds ; but care must be taken not to bring it too near the crest, or one margin will sink below the other.

The latissimus dorsi, with a few fibres of the external oblique, and the internal oblique are divided first and all hæmorrhage stopped. The fascia lumborum is slit up on a director for the whole length of the wound and the outer border of the quadratus exposed. A quantity of loose fat, in which the kidney is embedded, and the transversalis fascia at once come into view, the latter in some cases closely resembling the peritoneum in appearance. This must be teased through gently with forceps, the bleeding stopped, and the finger introduced to ascertain the position of the kidney. If the bowel is distended, the non-peritoneal surface generally rises into the wound at once, so that there is no difficulty. If it does not, the bowel may be filled with air from the anus by means of Lund's insufflator, but this is rarely required. As a rule, it is sufficient to pass the finger down into the angle between the quadratus and psoas, dividing the edge of the former a little if it is necessary, and by rolling the patient over to the left side allow the bowel to fall against the digit. The intestine should now be hooked well forward into the wound, the sides of which are held apart by retractors, in order to make certain that the portion exposed is really the colon. This is especially necessary on the right side ; it has happened to several of the best operators to open the loop of the duodenum by mistake. If it is full of hard scybalous fæces, or if one of the appendices epiploicæ can be recognised, it is usually sufficient ; but the only absolutely sure test is the presence of a band of longitudinal fibres, and when the non-peritoneal surface is exposed these are remarkably inconspicuous. Allingham, junior, who found an ascending and a descending mesocolon in five-sixths of the cases he examined, considers it advisable, unless the intestine presents itself in the wound, or can be recognised beyond all doubt at once, to open the peritoneal cavity, and by introducing the finger, or if the colon is much displaced, the hand, to find the portion of bowel required and bring it up to the surface. The cut edge of the peritoneum is then to be stitched to the skin so as to shut out the abdominal muscles from the wound, and the bowel secured in position.

When the intestine must be opened at once, a large curved needle is passed through the skin on one side of the wound, across the bowel, and then through the skin from within outwards upon the opposite side again. The same thing is done with another needle about an inch lower down. The ends of these sutures are to be held by an assistant. A small puncture is then made with a tenotomy-knife in the centre of the square so marked out, and the two threads, as they traverse the interior of the bowel, are caught up and pulled out in loops by means of an aneurysm-needle. As soon as the loops are cut, the bowel is held up against the skin, slightly overlapping it, by four silk sutures passing through its whole thickness. Additional security may be obtained by passing other sutures where required, either to hold the bowel to the skin, or to bring the angles of the skin wound together; and often it is advisable to place a series of buried catgut sutures in the wound to close, as far as possible, the planes of cellular tissue between the muscular strata.

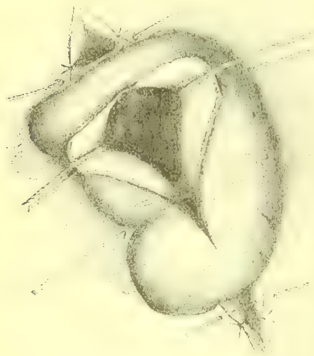


FIG. 381.—Method of securing bowel in lumbar incision.

Whenever it is possible the opening of the bowel itself should be postponed; union by the first intention may make everything secure within three days, and prevent all fear of fæcal extravasation and suppuration, and an interval of only a few hours can appreciably diminish the risk. The intestine may be secured in position by sutures passing through its muscular wall only, the mucous membrane being carefully avoided, or by means of Howse's forceps, which are made to grasp small folds of the muscular coat at intervals of about half an inch, and are then laid flat upon the skin and kept in position by broad strips of plaster.

In any case, it is absolutely essential to draw the bowel well up into the wound, so as to form a spur on its deep surface and prevent the fæces passing beyond; unless this is done the relief is exceedingly imperfect, and fæces may collect in the part below, and give rise to serious inconvenience. Madelung, to obviate this, and to prevent the irritation of fæces passing over a cancerous surface, has divided the bowel completely, sutured the upper end to the lumbar wall, and completely closed the other; but, as Greig Smith points out, this is open to the objection that, if the stricture becomes closed, there can be no escape for the foul and decomposing discharges in the lower segment. When the opening is a considerable distance above the seat of stricture, and the bowel is much distended, it is of advantage, as soon as the parts are fairly firm, to introduce the tube and gently wash out the accumulation from below. Afterwards the spur ought to be sufficient to prevent anything more passing on.

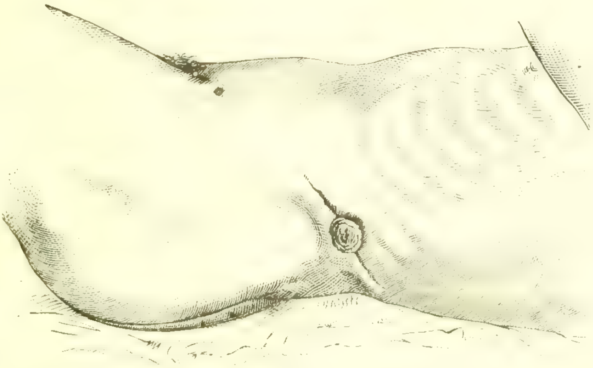


FIG. 382.—Artificial anus after colotomy with the oblique incision.

The discharge of fæces is, generally speaking, easy; exceptionally, when there are scybala, it may be necessary to wash them out, or even to extract them with forceps. The only dressings required are wood-wool, or some other absorbent antiseptic material in large pads, changed as frequently as necessary, and some zinc or boracic ointment around the margins of the wound. Afterwards an apparatus must be worn to support the opening and collect any fæces that may escape. Ivory or india-rubber rings may be used, fixed to an abdominal belt, so that there is a certain amount of pressure, as well as tension, around the opening; but in many cases patients find the greatest amount of convenience from absorbent pads covered on the outer surface with oiled silk, and secured by a linen binder.

INGUINAL COLOTOMY OR LAPARO-COLOTOMY

This is performed in the left inguinal region, but when it is desired to open the cæcum or the ascending colon, a similar operation may be carried out on the right side.

Various incisions are recommended, but in the majority of instances one two inches in length, parallel to Poupart's ligament, and about one inch nside the anterior superior spine, fulfils all requirements. Ball prefers the inea semilunaris, as there is no muscular substance divided. All bleeding nust be stopped before the peritoneum is opened. As soon as this is done he finger is introduced and passed along the lower margin of the iliac crest until the mesentery guides it to the sigmoid flexure, and its condition, with regard to distension and the situation of the stricture, is ascertained. The parietal peritoneum is then sutured to the skin, so as to exclude the muscles of the abdominal wall, and a loop of intestine, with a sufficient length of mesentery, is pulled out and secured. The most effectual and the simplest way of forming a spur is that devised by Allingham, junior. A needle, hreaded with carbolised silk, is passed through the mesocolon behind the bowel, and through the whole thickness of the abdominal wall on either side of he opening, so as to sling the intestine up and bring its posterior wall forwards.

The sides of the intestine are then fixed all round to the margins of the skin by silk sutures passing through the muscular and serous coats only, and leaving at least two-thirds of the circumference of the bowel protruding between the rows. A few hours' delay in opening the intestine is even more essential here than in the lumbar operation.

Ball recommends that a loop of intestine should be pulled out through the wound, emptied, as far as possible, by gentle pressure, and secured for the time by clamps placed above and below, so that no fæces can escape when it is opened. A series of sutures is then passed, as already described in lumbar colotomy, through the whole thickness of the abdominal wall on either side, and across the bowel between the clamps. One should pass through the mesocolon in the angle of the loop, and three or four through the bowel above and below. When these are placed in position the convexity of the bowel is opened, the mucous surface carefully cleansed, and the threads fished out, divided, and secured, with the exception of the outermost one at either end. The mucous membrane is adjusted all round, the angles of the wound brought together, leaving the handles of the clamps still protruding, and then at last, when everything is secured, the clamps are withdrawn, one at a time, and the opening closed instantly by tightening up the sutures that have been left. In this way the upper and the lower ends of the loop are fixed securely side by side, and no escape of fæces is allowed until the clamps are unscrewed. When the bowel must be opened at once this plan presents considerable advantages over the other; but great care is necessary to secure it sufficiently firmly without bruising it, especially as the walls are not unfrequently much softened and congested. Redundant portions of the bowel can be removed with scissors afterwards, as far as may be necessary, without its being felt.

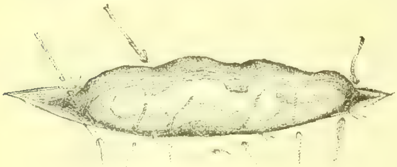


FIG. 383.—Method of securing bowel in inguinal incision.

INGUINAL *v.* LUMBAR COLOTOMY

No reliance can be placed upon the older statistics, which give the former of these operations a much higher rate of mortality than the latter. More recent experience tends to show that, so far as this is concerned, if there is any material difference, the balance is rather on the other side.

In a certain number of cases lumbar colotomy is almost impossible: a fæcal fistula may be formed in the loin, sufficient so long as the bowel is immensely distended; but when there is no mesocolon, and the walls are perhaps four or even five inches in thickness, it is not possible to draw out the bowel sufficiently. The peritoneal cavity, it is true, is always opened in the one, but it very often is in the other, and sometimes without its being known. The inguinal operation is shorter, and the wound much smaller; the large intestine can be found more easily, and can rarely be mistaken; the seat of stricture can often be ascertained, and it is always possible to make sure that it lies below the wound. So far as the after-treatment of the case is concerned, there is no question as to the side upon which the advantage lies: the tendency to prolapse may be slightly greater in the inguinal region, but it is easily controlled, and the patient can attend to himself much better. The only exception is where the bowel is very greatly distended and the walls much thinned; then it is probable that the immediate risk is less in the case of the lumbar than the inguinal. The actual distance between the two openings is not more than four inches, so that very little is gained in this respect by the lumbar incision.

Prolapse of the mucous membrane of the bowel is more frequent after the inguinal than the lumbar operation, but this may be prevented to some extent by drawing down the sigmoid flexure as far as possible and fastening in the wound the highest part that can be reached.

It must not be forgotten that patients who are suffering from abdominal distension and are worn-out from intestinal obstruction, frequently take anæsthetics exceedingly badly, and that the position necessary for the lumbar operation still further impedes their respiration.

ENTERECTOMY

Resection of the small intestine may be performed when the condition of the bowel is hopeless from gangrene, irreducible intussusception, or matting together and bending; for stricture, simple or malignant; for perforating wounds, or as a plastic operation for the cure of artificial anus. If the condition of the patient and of the wall of the intestine is such as to admit of it, the two ends may be sutured together and returned into the abdominal cavity at once. In other circumstances an artificial anus must be formed, and left to be dealt with later on.

The operation, following Greig Smith, is conveniently divided into three steps: (1) the isolation of the bowel, so that it can be drawn out of the abdominal wound and emptied; (2) the resection; and (3) the suturing of the ends, either to each other (enterorrhaphy) or to the wall of the abdomen.

1. *Isolation.*—In most instances there is but little difficulty: a part that is gangrenous or has been wounded can generally be drawn outside and thoroughly examined. More preparation, however, is required when there is an artificial anus: the abdomen must be opened above and below, the orifice of the bowel closed, and the adhesions carefully dissected off; and in the case of malignant stricture very strict examination is necessary to make sure that the whole of the growth can be taken away. One or two glands may be removed, but if there is any extensive infiltration, or if the intestine is adherent, the attempt is not likely to succeed. As soon as the bowel is drawn out, it is laid upon a flat carbolised sponge, and the opening into the abdomen packed with more sponges to prevent the intrusion of fæcal matter and the escape of more of the intestine.

2. *Resection.*—As soon as the bowel is safely held away from the margin of the wound, it should be opened and encouraged to empty itself as far as possible. Whether it should be secured above and below with clamps, or merely held with the fingers, depends, to a large extent, upon the condition of the bowel itself and upon the character of the assistance at hand. The more instrumental compression can be dispensed with the better, but it must be allowed that nothing can prevent the escape of the contents more effectually or maintain the cut edges in better apposition for the application of the sutures. Many forms have been devised, and something may be said in favour of nearly all, but perhaps the simplest is that adopted by Makins. It merely consists of a pair of spring-catch forceps with longer blades than

usual, and a screw so that they can be tightened to any required extent. The blades are covered with rubber tubing to avoid injury to the coats of the bowel.

If the portion of bowel to be removed is of any length (in Koeberlé's case the amount was over two yards) a triangular segment of mesentery to correspond must be taken away to prevent kinking afterwards. The base of the triangle should be rather smaller than the interval between the ends of the intestine, so as not to interfere with their blood-supply, and the raw edges must be adjusted to each other by means of a continuous catgut suture carried over and over the margins. In most cases, however, this is scarcely necessary; the folds may be drawn together and the base so formed stitched to the intestinal walls. The line of section through the mesentery should always be carried as close to the attached margin as possible, to preserve intact the row of anastomotic loops from which spring the vessels supplying the wall itself. Any part of the intestine separated from this is sure to slough. MacCormac recommends that the section through the bowel should not be exactly transverse, but that rather more should be removed on the convex side, as by this, after the suturing is complete, the tube remains somewhat straighter.

3. *The suturing.*—The variety of intestinal sutures that have been described is simply hopeless; the essential features are: (1) that the peritoneum should be in contact over a sufficiently broad surface; (2) that no suture traversing the mucous membrane should pass at once through the serous coat as well, or it will inevitably act as a seton, carrying the contents into the peritoneal cavity; if sutures are used to bring the mucous edges together, they should be independent, and tied on the mucous surface, so that if there is any ulceration they may fall into the cavity of the bowel; (3) that the sutures should be sufficiently close (eight to the inch at least) and pass sufficiently deep to secure a firm hold. Each should take up the serous layer, the whole thickness of the muscular wall (which is much thinner in the ileum than the jejunum), and a few fibres of the submucous coat. Especial care is necessary when working near the attachment of the mesentery, as the serous layer at this spot is separated by a cellular interval from the structures beneath, and it is nearly always here that extravasation occurs. The last requisite is that the method should be one capable of rapid application.

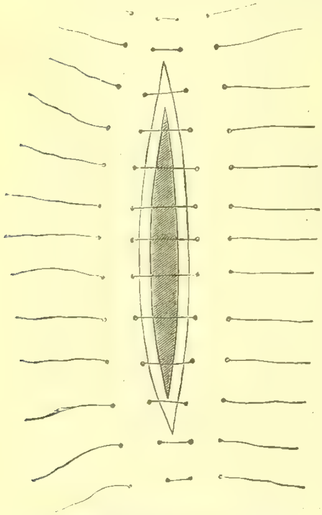


FIG. 384.—Lembert's suture.

Fine China twist is the best material, and one row of sutures at least should be interrupted, taking care that they are not sufficiently tight to cause sloughing. Continuous sutures are admirably adapted for securing contact and for strengthening weak places; moreover they prevent over-distension of the bowel, but if it contracts they become loose at once.

Treves advises that there should be two rows: one through the mucous membrane, which, as soon as the bowel is divided, becomes everted; and a second, farther back, turning this in again, through the serous and muscular layers. For the latter Lembert's is the most useful; the needle is entered about three to three-and-a-half lines from the margin, passed down through the serous and muscular coats until the resistance of the submucous layer is felt; and then, after picking up a few fibres of this, brought up again about one line from the cut edge, and introduced into the opposite end of the bowel in the reverse direction. Czerny combines Lembert's with another row inside, passing, not through the mucous membrane only, but through the whole thickness of the bowel.

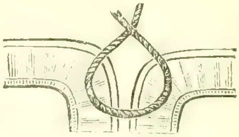


FIG. 385. — Lembert's suture, tied.

One or two sutures should always be passed across the cut edges of the mesentery immediately above its attachment, in order to obliterate as far as possible the triangular space that normally exists there, and allow all the sutures to pass through the serous coat. Greig Smith speaks very highly of Halsted's plain quilt suture, and makes a most ingenious use of it.

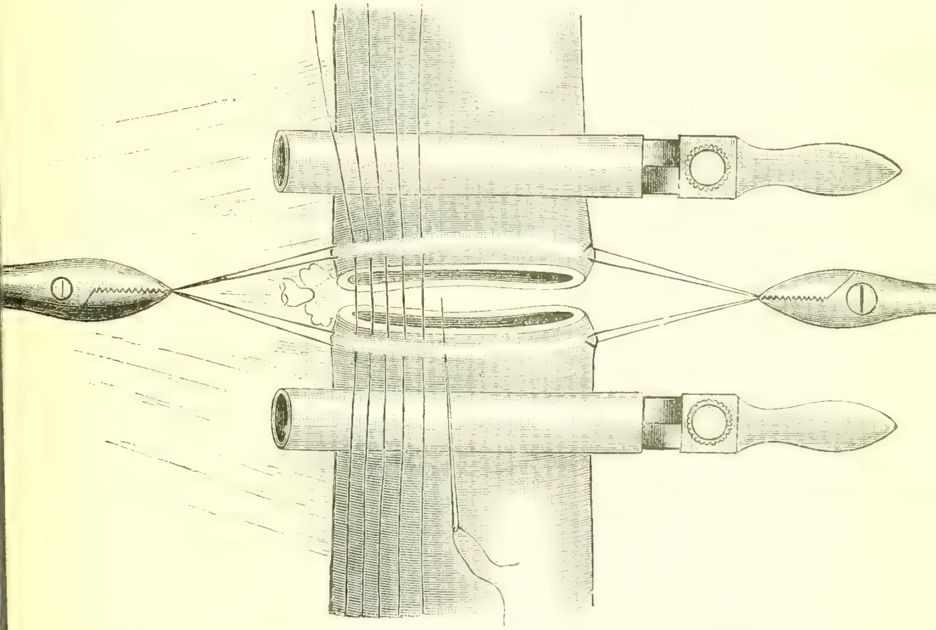


FIG. 386.—Drawing to show method of intestinal suture. (Greig Smith.)

'The intestine has been cut away, the mesentery divided as close to the bowel as deemed desirable, and no wedge-shaped portion removed. Two Makins' clamps, covered with rubber tubing, have been applied, at a distance of about half an inch from the divided ends of the bowel. A purse-string stitch has been so arranged along the divided margin of the mesentery that it draws together the gap of cellular tissue and the attached margins of gut, while it leaves free small flaps of peritoneum, which may be grafted on to the base of the line of union. Four quilt sutures have been inserted on the opposite sides of the divided gut, in the exact line in which the Lembert sutures are to be placed; the two on each side are to be gathered together in the blades of catch-forceps, and gentle and steady traction made on them by an assistant. This raises a well-defined fold along the edge of the bowel: into this fold the sutures are inserted. The traction on the quilt-stitches makes certain that equal distances of the bowel are arranged for suturing, and also, by raising a fold, makes the insertion of Lembert's stitches more easy and ensures their being placed in a straight line.' The quilt-sutures are tied the last of all, and, finally, any redundant mesentery is fixed along the line of union of the bowel. Any spot that appears weak may be strengthened by Dupuytren's or Appolito's continuous suture applied outside.

Senn ('Annals of Surgery,' 1888), who has performed on animals a simply invaluable series of experiments, prefers a modification of Joubert's suture where direct union of two cut ends is required. The time is very much shorter; there is less danger at the mesenteric edge; the number of sutures is smaller, the risk of their giving way prematurely and of their perforating the mucous membrane is not so great, and there is not so much fear of gangrene.

The direction of the bowel is first ascertained by Nothnagel's test (a crystal of a sodium salt placed upon the serous surface, causing ascending peristalsis), the upper end, which is to become the intussusceptum, is lined with a soft pliable rubber ring (made from a flat rubber band, one-third to one-half of an inch in width, by securing the two ends together with catgut sutures), which is stitched to the wall at its lower edge with a continuous catgut suture. The two ends of the bowel are then fastened together with four catgut sutures, placed at equal distances, and the upper one, supported by the ring inside, is pushed into the other so as to invaginate it. The intussusceptum must be a little longer than the ring, so that there may be a distinct neck which can be grasped by the intussuscipiens. A few superficial sutures are required to prevent disinvagination.

The ring acts as a splint, keeping the part at rest, and its pressure (which must not be too great) is useful in securing the apposition of the serous surfaces. When the catgut softens it comes away of itself.

There is no doubt that by this process the operation may be performed in less than one-fourth the time, and that in animals it succeeds perfectly. It must be remembered, however, that the human intestine is of larger calibre, and its walls for the most part thinner. Probably it would not succeed in cases of obstruction where the upper part of the intestine is filled with fæces, or its walls much softened and congested. For such the formation of an artificial anus is to be preferred. In perforating wounds, however, where perhaps several resections have to be performed, the gain in point of time alone would be of immense advantage.

Senn has also practised a most ingenious system of omental grafting, both in ordinary cases of circular suturing and in his modification of Joubert's method. A flap about an inch in width (or a little more), and sufficiently long to reach round the bowel, is taken from the margin or the middle of the omentum, and laid upon the line of junction; two catgut sutures are used to fasten it, each passing twice through the flap (once at its base and once at its free end), and through the mesentery of the bowel in between, care being taken that when the sutures are tied they correspond in direction to the course of the mesenteric vessels. At first the attachment of the base of the flap to the omentum was preserved intact; but in his later experiments, owing to the possible objection that kinking might be produced by this, perfectly isolated strips were used and succeeded equally well. Slight scarification of the serous surface, not sufficient to cause bleeding, is, according to the same authority, of additional advantage in securing early and firm adhesion of the coats.

Where it is not advisable to return the bowel into the peritoneal cavity, the two ends are sutured carefully to the skin around the abdominal wound. A few stitches should be put in first to connect the parietal peritoneum to the skin and exclude the muscles, and the external opening closed as far as possible; then the muscular and serous coats of the intestine are fastened with silk at as many points as may be necessary all round to the conjoined peritoneum and skin. If the bowel has not been emptied, but merely the contents prevented from descending by means of a clamp, this should not be removed until everything is secure, for fear of the fæces in their first rush finding their way into the peritoneum.

The peritoneal cavity itself should be interfered with as little as possible, if blood has escaped into it in any quantity it must be sponged out; but all bleeding points should be secured before it is opened, and the section through the bowel (which, owing to the congested condition of the walls, often bleeds freely) should not be made until it can be well isolated. Fæcal extravasation is very much more serious, but even then recovery has followed after the peritoneum has been thoroughly washed out with a hot solution of boracic acid; whether a drainage-tube should be used or not must depend upon the amount of peritonitis.

Whether the bowel should be returned into the peritoneal cavity at once and the abdominal wound closed, or an artificial anus formed, must be decided for each case by the condition of the patient and of the intestines. There is no doubt that, for obstruction at least, the former of the two is the less successful; but it must not be forgotten that an artificial anus high up in the small intestine practically means starvation, and that if the patient is to be cured there is all the risk attendant upon the second operation. In the case of wounds, where the bowel is healthy and the patient not too much depressed, there is no doubt the operation should be completed at once.

In a few instances an intermediate course has been followed: the bowel has been returned just within the wound and secured in that position by one or two sutures. This may be done if there is any doubt as to the security of the stitches in the bowel, and several cases in which it has been adopted have recovered after a slight discharge of fæces through the abdominal wound.

Colectomy

Resection of the colon has been practised in cases of gangrene (upwards of fifteen inches of the transverse portion have been excised successfully in umbilical hernia), irreducible intussusception, gunshot injury, and stricture; but so far, at least, as malignant disease is concerned, and this is the chief of the causes for which colotomy is performed, the advisability of such a proceeding is very doubtful. It rarely happens that the case is diagnosed, or that such a serious operation is agreed to by the patient in time for complete removal; adhesions are nearly always present, either to the neighbouring viscera, or to the parietes of the abdomen, and recurrence within a short time is only too probable. As Kendal Franks has shown, the primary mortality is exceedingly high (though the percentage with improved methods is certainly growing smaller), and of those who recover more than half are known to have suffered from a recurrence within a few months. Colotomy can give such complete relief with such small risk, that before colectomy is preferred it must be shown that there is a reasonable prospect of cure.

The operation for the transverse colon is performed through the middle line, and portions of the ascending and descending colon have been removed in the same way, but this must be considered exceptional. As a rule, so far as these are concerned colectomy is only possible when the seat of disease is opposite the lumbar incision and the bowel is sufficiently free for it to be well pulled out. The method is the same as in enterectomy: peritoneal surfaces must be brought together as far as possible; and where this cannot be done the muscular coats must be accurately sutured, but this greatly increases the risk of suppuration and retroperitoneal abscess.

Cæcectomy

This operation, which is essentially of the same description, has been performed on several occasions, the whole of the cæcum being removed and the ileum joined to the ascending colon.

Intestinal Anastomosis

By this is meant the formation of a fistulous opening between two portions of intestine, or between the intestine and the stomach, so as to secure the direct transit of the contents from one to the other. Hitherto it has not been practised to any extent, but probably it has a great future before it as an alternative to resection and circular suture or implantation. It should certainly be preferred in all cases in which it is impossible to remove the cause of obstruction; in which, after resection, continuity cannot be restored without undue traction, and in which the pathological conditions causing the obstruction are not such as of themselves to constitute a danger to life. Its importance in connection with carcinoma of the pylorus alone may be imagined from the fact that, in Lücke's clinic, out of fifty-two cases selected for pylorectomy, only five were free from metastases, and that the mortality of the operation is 75 per cent.

The particular name of the operation depends upon the locality, gastro-enterostomy, jejunoileostomy, ileoileostomy, ileocolostomy, &c. The principle is the same in all.

Senn's Methods

1. *Where the two segments are placed side by side.*—Decalcified plates of bone, one inch wide by three inches long, are prepared from the tibia of an ox by soaking them in hydrochloric acid: when sufficiently flexible they are washed free from acid, dried between plates of tin so that they may not curl up, and kept until wanted in absolute alcohol. In the centre of each plate an opening is drilled five-eighths of an inch by one-sixth; and around this four smaller holes for sutures, one on each side, one at each end, about one-sixth of an inch from the central opening. The sutures, which are of fine China twist (catgut of sufficient strength is too coarse and the knots too large) are secured beforehand on the inner surface of the plate and passed through the holes to the other side.

A longitudinal incision is made on the convex side of the intestine, away from the mesentery, sufficiently long to allow the plate of bone to be slipped inside and arranged parallel to the bowel, against its mucous surface. The two end sutures are allowed to hang out through the opening; the two lateral ones, which have needles attached to them, are passed through the wall of the bowel, near the incision, so as to fix the plate and prevent eversion of the mucous membrane. A second plate is arranged in a similar way inside the other portion of intestine; and then the serous surfaces are brought together so that the orifices correspond, and the opposite sutures tied. The knots of the lateral ones lie between the peritoneal surfaces.

By this, accurate approximation is secured over a surface corresponding to the size of the plates; there is no risk of cutting off the blood-supply by the multitude of sutures; the plates act as splints and secure perfect rest; and the time of the operation is only fifteen minutes. Senn found that, in dogs, bone-plates, if thoroughly decalcified, were digested too soon in the stomach; but it must be remembered that the gastric juice is much more acid in them than it is in man.

2. *Where the end of one segment is implanted into the side of the other.*— In this case the proximal end of the distal segment must be thoroughly invaginated and closed with a continuous catgut suture passing through the peritoneal and muscular coats. Senn has shown that if it is treated in this way it soon atrophies and shrinks up, and there is no fear of its becoming the seat of fæcal accumulation.

For this Senn makes use of the modification of Joubert's suture already described (p. 1088). A rubber ring is secured in the distal end of the proximal segment; two catgut sutures, each provided with two needles, are passed from within out, at opposite sides, through the upper margin of the ring and the whole thickness of the bowel; each needle is then passed into the wall of the colon, about one-third of an inch from the margin of the opening, penetrating the peritoneal, muscular, and submucous coats only, and emerging on the same surface. As soon as they are all secured at corresponding points, gentle traction is made upon them while the end of the proximal segment is pushed into the side of the distal one, so as to form a limited invagination. The sutures are then tied only sufficiently to prevent any disinvagination. The pressure of the ring keeps the part at rest and secures accurate adaptation, and the invagination prevents any escape of the contents and secures the sealing of the wound. Superficial sutures are not required.

This method, of course, is only applicable where a smaller segment can be implanted into a larger one, and therefore cannot be used in the case of the stomach.

Artificial Anus and Fæcal Fistula

In artificial anus there is a free communication between the skin and the bowel, the whole or nearly the whole of the intestinal contents escapes, and the part below shrinks and collapses. In fæcal fistula, on the other hand, the channel is narrow, it may be long and tortuous, and the greater portion of the contents follow the natural route. The one arises from the loss of a loop of intestine, or from destruction of the greater portion of the circumference of a short segment, the bowel being sharply bent upon itself; the other from sloughing of a small part only of the wall; but no hard and fast line can be drawn between them.

The most important practical distinction is the existence in the former of a spur or septum opposite the opening, which prevents the contents passing on. The posterior wall of the bowel is pushed forward from behind by the weight of the viscera; a ridge is formed on the mucous surface, and this grows more and more prominent until at length it overlies and closes the opening of the lower segment; the whole of the fæces then discharge themselves externally, and this part of the bowel, from being never used, shrivels up to a narrow cord.

The most common cause is hernia, and for this reason the opening is generally situated either in the femoral or inguinal region; but it may arise from injury, carcinoma, internal strangulation, fæcal abscess, circumscribed peritonitis, and many other causes; and the communication may be formed with the bladder or vagina, or, in very rare cases, with other parts of the bowel. If the opening is of any size, prolapse of the mucous membrane is almost sure to occur; and sometimes, owing to the stretching of the adhesions between the two portions of bowel, or between the bowel and the skin, hernial protrusions make their appearance by the side.

Treatment.—Where there is merely a fistula and the passage below is fairly open, the orifice often closes in of itself. The discharge becomes less; the cicatricial tissue around contracts; the patient regains strength (unless the opening is high up in the intestine); and even if the cure is not complete, the operation is less extensive, and the condition of the patient more satisfactory. This sometimes occurs in that form of artificial anus which follows femoral hernia; and the process may be hastened by pressure steadily applied, by drawing the edges together with strapping, button sutures, or hare-lip pins, or by the use of the actual cautery. Sometimes a small plastic operation will succeed. In most cases of artificial anus, on the other hand, and whenever the orifice is high up, so that the patient is in danger of starvation, further measures are essential.

1. Where the chief difficulty arises from the presence of a spur, an attempt may be made either to divide it or to press it back. The simplest method is that suggested by Mitchell Banks: a stout piece of rubber tubing, secured by a ligature so that it shall not escape, is passed through the orifice into the upper and lower ends of the bowel, resting against the edge of the spur. The contents of the intestine, especially if the opening is high up, pass through it more or less, and by its pressure it wears the projection back and brings the two portions into the same line again.

If this fails, and the spur is very distinct, it may be divided by means of Dupuytren's enterotome. This consists essentially of a pair of forceps, the ends of which are broadened out into flattened discs or circles; one of these is passed on each side of the septum, and then, after making sure that there is no loop of intestine caught between, they are slowly and cautiously tightened up from day to day, until at the end of a week the septum sloughs through. Adhesions meantime form around and completely shut out the peritoneal cavity. The mortality attending this procedure is exceedingly low (no more than 8·5 per cent.); but of course it is only applicable to selected cases.

2. Where the opening is very high up and the patient is gradually losing ground; where there is no well-defined spur; and where there is more than one opening, resection and suture of the bowel afford the only hope of cure. This must be done on the principles that have been already described, but even when every precaution has been taken the mortality, according to Makins,

amounts to nearly forty per cent. The patient for a day or two before is fed wholly with enemata ; the bowels and the skin round are thoroughly cleansed ; and an incision is made into the peritoneal cavity to ascertain the amount and extent of the adhesions and the direction of the bowel. After this the ends are carefully freed from surrounding structures, drawn well out of the wound (which is immediately plugged with sponges), clamped if necessary, resected and sutured. If the lower end of the bowel is much contracted, there may be great difficulty in this ; and it may be necessary to divide it obliquely so as to secure a sufficient extent of cut surface ; but every attempt should be made, both before and during the operation, to dilate it quietly and gradually. Afterwards the bowel is returned into the peritoneal cavity and the abdominal wound treated as in laparotomy. If there is any doubt as to the security of the sutures, it is as well to retain the bowel close to the surface.

After-treatment.—The after-treatment of operations upon the intestine is essentially the same as that for hernia ; as soon as the patient comes round from the anæsthetic he must be placed under the influence of morphia and kept perfectly quiet for at least eight days. A little ice may be given to allay thirst, but he must not be allowed to suck it constantly : the temperature must be maintained, and where the upper part of the intestine is concerned the strength kept up with nutrient enemata. Barker has shown that in a case of gunshot wound six days suffice for sound union, but probably the time required in obstruction would be considerably longer. Artificially digested food should be given at first, and in very small quantities. In colotomy, of course, the method is different, and nourishment may be taken by the mouth from the first.

If the bowel has been returned the wound does not require dressing for five or six days, unless a drainage-tube is used or peritonitis was present. Sometimes a small discharge of fæces takes place for a time, and then gradually ceases, caused probably by the giving way of one or two of the sutures. Where an artificial anus is left, large absorbent and antiseptic pads should be used and changed as often as required, the skin being protected, as far as possible, by vaseline or simple ointments. When the opening is near the upper end of the intestine, the excoriation may prove a difficulty.

SECTION VII.—SURGICAL AFFECTIONS OF THE LIVER AND PANCREAS

ABSCESS OF THE LIVER

ABSCESSES of the liver may arise from wounds and contusions, from exposure to cold, or from suppuration in connection with hydatid cysts ; but, in most instances, they are secondary to infection from the intestine, and occur chiefly in those who have lived in tropical climates and have suffered from dysentery. Sometimes they are multiple, scattered through the liver in all directions, as in fatal cases of pyæmia ; more frequently they are single or few in number, though they may have been formed by the gradual coalescence of numerous small foci, and then they may be very large, capable of holding four or five pints of fluid. The pus is usually dark chocolate in colour and sometimes fœtid. At first the abscess may be deeply seated; as it enlarges it approaches nearer the surface, until either it bursts into the pleura, peritoneum or pericardium, or else, if this is prevented by the formation of adhesions, discharges itself externally or into the bowel.

Diagnosis.—The diagnosis of deep-seated abscess in the early stage is exceedingly difficult. A history of residence abroad, particularly of any rectal trouble, even years before; the occurrence of rigors, or of general feverishness with pain and tenderness over the region of the liver; a muddy, perhaps jaundiced, complexion; irritability of the stomach, with vomiting and other signs of hepatic congestion, may excite suspicion, but no positive diagnosis can be made without exploration by means of an aspirator. In the later stages, when there is a distinct enlargement of the liver, or when the skin over the surface of the abdomen is red and œdematous, this difficulty disappears; but the abscess must usually attain a very large size before it can produce such an effect.

Hydatids of the liver may be distinguished by the slowness of their growth, and by the absence of pain and feverishness; but this, of course, fails if the cyst is suppurating. A certain amount of difficulty may arise in the case of large single gummata of the liver, and of rapidly growing tumours either of this organ or of the kidney. Pleurisy and pneumonia are not unfrequently present, especially when the abscess is situated near the posterior surface, and very great care may be required to make certain of the cause.

Treatment.—1. If the skin over the swelling is red and pits on pressure there can be little doubt either as to the existence of an abscess or the presence of adhesions. In such circumstances an aspirating needle may be used as a preliminary to act as a guide, but as soon as it has entered the cavity and the diagnosis is confirmed, the opening should be enlarged, so that the pus can escape as freely as possible, and a full-sized drainage-tube inserted. The following day, when the adhesions are firmer, the abscess-cavity may be explored with the finger to make sure there are no other sacs in the immediate neighbourhood, and, if necessary, washed out with iodine or some other antiseptic.

2. When there is no certainty as to the presence of adhesions the choice lies between aspiration, drainage with a trocar and cannula, and incision.

Aspiration is chiefly of use for exploration; it rarely happens that an abscess-cavity is completely emptied, and nearly always the swelling appears again within a few days. In a few instances, however, a cure has followed after two or three repetitions.

Puncture with a trocar and cannula is also open to grave objections. If adhesions are present already, it is more satisfactory to make a free incision and allow of thorough exploration and drainage; if they are not, the peritoneal cavity is opened without any safeguard to prevent the pus entering it. Further, the constant movement of the liver in the abdominal cavity frequently renders the retention of a tight-fitting cannula or of a stiff drainage-tube a matter of very considerable difficulty.

Incision directly into the abscess-sac can only be practised when the skin over it is reddened and it is certain that the walls are adherent. If this is not definite, either the operation must be carried out in separate stages or an incision made into the abdomen over the swelling, the surface of the liver exposed, and the abscess opened with the usual precautions to prevent its contents entering the peritoneal cavity. The preliminary steps are the same in both, but while in one the incision is only carried down to the parietal peritoneum, and is then plugged, so that adhesions may form beneath, in the other the abdominal cavity is opened at once and the surface of the liver examined. In a few cases omentum has been interposed, or it has been found that the abscesses are multiple and that there is no hope of thorough evacuation; but if no difficulty of this kind is apparent, the wound is carefully packed round with sponges and an aspirating needle thrust into the swelling. As soon as the pus is found the opening is enlarged freely with the knife, and the contents of the abscess allowed to escape completely; the assistant, meanwhile, carefully supporting the liver on either side so that it shall not fall away from the surface of the abdomen. When the sac is emptied the cavity may be explored with the finger and the walls stitched to the skin-margins of the wound all round.

An aspirating needle may be thrust through the two layers of the pleura and the diaphragm for the sake of exploring the posterior surface of the liver without risk; but if a permanent drain is required, a free incision should be made down to the parietal pleura, a portion of one of the ribs being resected if necessary, the two layers of the pleura accurately sutured together with catgut (there is no difficulty in this in the lower intercostal spaces), and then the trocar and cannula thrust through, so as to avoid the risk of air or pus entering into the pleural space.

Hydatid Disease

Hydatid cysts are of common occurrence in connection with the liver, and not unfrequently attain an enormous size, diverticula having been known to extend down into the iliac fossa, and even under Poupart's ligament. As a rule they are single, lined with a characteristic laminated membrane, and contain a clear non-albuminous fluid, the specific gravity of which is under 1015; but more than one may be present, and most of those over a certain size contain numbers of smaller ones in their interior. Outside is a very vascular layer formed by the continued irritation of the structures around.

The symptoms to which they give rise are very obscure at first, and depend mainly upon the locality. Their increase is slow and painless, without any fever; they may occur at any age, forming a tense elastic swelling which slowly extends in the direction of least resistance. Sometimes there is a smooth rounded prominence on the front wall of the abdomen, dull on percussion, and tense, without being tender. Occasionally fluctuation can be made out, or what is known as hydatid fremitus—a peculiar thrill only felt over cysts of some considerable size. More often the cyst grows downwards, simulating enlargement of the liver, and in a few cases it has reached so far as to be mistaken for hydronephrosis, and even for ovarian tumours. Not unfrequently serious consequences arise from pressure upon neighbouring organs. Syncope has been known to occur; vomiting is not uncommon; respiration may be interfered with; or jaundice, ascites, or anasarca may follow.

Rupture of the cyst into the peritoneal cavity may occur (especially as the vascular adventitia is often defective on the serous surface), and is generally fatal at once. Communications occasionally form with the lung, so that the cysts are coughed up in numbers; but, as a rule, if the patient does recover, it is only after a long and severe illness. In a few cases the hydatids have been known to remain stationary for years and at length undergo degeneration and dry up into a calcareous mass; but suppuration with high fever and severe constitutional disturbance is much more common.

The **diagnosis** rests mainly upon the age of the patient, the smooth, even shape of the swelling, and the absence of pain and feverishness. The chief difficulty arises with pleurisy, hydronephrosis, ovarian cysts and tumours of the liver; but as a rule exploratory puncture is conclusive. When suppuration has set in it is naturally impossible to distinguish it from abscesses due to other causes.

Treatment.—There is no doubt that hydatid cysts are easily killed by withdrawing a small quantity of fluid from their interior, and when they are of moderate size only and are deeply embedded in a solid organ, there is a reasonable hope that if this can be done they may become calcified and dry up. In the case of larger ones, however, this is rarely satisfactory, partly owing to the risk of suppuration, partly to the impossibility of getting rid of the daughter cysts they so often contain. For these free incision is the only method.

As in the case of abscesses, this may be carried out in two steps, an incision being made down to the parietal peritoneum and plugged so as to procure adhesion between the opposing surfaces some few days before the cyst is opened; or preferably the whole operation may be completed at once. The surface of the liver where the cyst projects must be exposed by a free incision through the abdominal wall, the opening carefully packed with sponges, and then, while an assistant supports the liver by external pressure, a free incision is made into the sac and its contents evacuated. The side of the cyst is hooked up with the finger, the wall of the sac peeled off (disturbing the adventitia as little as possible), and then the edge accurately sutured to the skin. On one or two occasions the sac has been sponged out with iodine afterwards.

Tapping hydatid cysts with an aspirator is occasionally followed by urticaria, vomiting, and other symptoms of poisoning. I have known one instance in which sudden death occurred, and Bryant has recorded another; it may have been due to the sudden entry of some of the cyst fluid into one of the large branches of the hepatic vein, but more probably to shock.

Diseases of the Gall-Bladder

Biliary Calculi

Gall-stones are formed for the most part in the gall-bladder, although a few are met with in the hepatic duct, coming down from the liver, and they may become impacted either in the neck of the gall-bladder, held in all probability by the peculiar folding of the mucous membrane, or in the hepatic, cystic, or common ducts. Sometimes they are single, or, at least, few in number, and of very large size; sometimes they are multiple, occurring by the hundred, and covered over with facets from mutual friction. Some are small, rough and soft, composed chiefly of bile pigments, others formed of cholesterine are hard and brittle. They are most common in women, and after middle life, although instances of their occurrence in children are not unknown.

The symptoms to which they give rise are very variable: it is not uncommon to find *post mortem* that the gall-bladder is full of them, without there having been any reason to suspect their existence during life.

In some cases there are frequent and excessively painful attacks of biliary colic, with or without jaundice, according to the exact situation of the obstruction. The patient is never free from pain, there is a constant weight or dragging in the hepatic region, made worse by movement, and coming on with especial severity a few hours after food, causing vomiting and great prostration. This may end suddenly and finally with the passage of the calculus, or, on the other hand, the stone may drop back into the gall-bladder, and all the symptoms return again within a few hours.

If the calculus is impacted the consequences are still more serious. When the obstruction is in the cystic duct the gall-bladder only is involved, and it may either become immensely distended (dropsy) or inflamed and suppurate (empyema); when it is in the common duct, in addition to this, the liver is affected, jaundice sets in, and at length, unless some relief is given, cholæmia follows. Usually this proves fatal within the twelvemonth.

Dropsy of the Gall-Bladder

Distension of the gall-bladder is nearly always due to impacted calculus; in some rare instances other foreign substances, fragments of carcinoma, trematodes, &c., have been found instead, and occasionally it results from stricture, gummata, or peritoneal inflammation. The contents soon become altered in character; the bile becomes more watery; after a time it loses its colour altogether, and at length it is replaced by a fluid that is either perfectly clear or is turbid from the amount of mucus it contains. The bladder itself swells up into a pear-shaped or semi-globular tumour which grows downwards towards the umbilicus. Usually it is overlapped at its margin by intestine, and there may be a clear note on percussion between it and the liver. The surface is smooth and uniform, firm and elastic to the touch, but sometimes very painful. The walls are nearly always thinned, and there is practically no limit to the size it may reach.

Empyema of the Gall-Bladder

Suppuration in the gall-bladder, which, according to Tait, is more usual when only a few gall-stones are present, rarely leads to a tumour of such size. The walls are thickened in some parts and thinned in others, adhesions tying it down to all the structures near; the tissues become soft and easily torn, and, if the gall-bladder itself does not slough, the pus gradually works its way through the wall at some point or other. Sometimes it bursts into the peritoneum, causing fatal peritonitis; more often it discharges itself either into the stomach, duodenum, or colon; perhaps most frequently of all adhesions form between the fundus and the abdominal parietes, and the abscess is either opened or breaks externally. If the obstruction is in the cystic duct this may give complete relief; if, however, the common duct is involved, a permanent biliary fistula is left, which usually proves fatal in the course of a year or two, from exhaustion.

Diagnosis.—Malignant disease of the liver, pancreas, pylorus, or of the gall-bladder itself, may cause a certain amount of difficulty. This is especially the case with the first mentioned, as biliary calculi are not unfrequently associated with carcinoma, though it is not easy to say in what relation they stand to each other. According to Tait, the presence of jaundice points distinctly to malignant disease, and, so far from rendering an operation advisable, suggests exactly the opposite conclusion, unless it is done merely as a temporary expedient for the removal of an obstructing calculus or the relief of biliary colic. Out of twenty cases operated on, carcinoma was present, or was very highly probable in every one in which there was jaundice.

Tumours of the kidney, particularly hydronephrosis and floating kidney, have often been mistaken for distended gall-bladder, especially when there has been a history of the previous passage of gall-stones, and *vice versâ.* The shape of the tumour and the relation that it bears to the bowel are the most important diagnostic points; but in many cases it is impossible to be certain without a preliminary exploratory incision.

Hydatid cysts, dermoid cysts, tumours in connection with the omentum, ovarian cysts, and other rarer forms of tumours, have occasionally given rise to difficulty. In any such case a small exploratory operation is infinitely more safe and more certain than needling or aspiration.

Operations upon the Gall-Bladder

According to Greig Smith, operation is required in all cases of empyema, dropsy, and persistently recurring colic. When jaundice is present the prognosis is much more grave, not only for the reasons mentioned above, but because of the much greater risk of hæmorrhage and the feeble power of repair. Still, it may be necessary to avoid the occurrence of cholæmia, and sometimes even under these conditions it is possible to effect a permanent cure—by crushing, for example, a calculus impacted in the common duct.

Aspiration through the abdominal wall cannot be recommended; it is not likely to effect a permanent cure, and it may lead to leakage through the puncture and peritonitis.

Free incision can only be practised where there is an abscess pointing through the skin.

Incision into the gall-bladder after exposure through an opening in the abdominal parietes (*cholecystotomy*) is a most successful operation. A vertical incision is made over the most prominent part of the swelling, and the muscles and peritoneum divided in the ordinary way; the finger is then introduced to ascertain the condition of the gall-bladder, and, if it is much distended and not too much bound down by adhesions, a fine trocar and cannula is thrust into it to draw off some of the contents, and allow it to be pulled out through the wound, the greatest care being taken to allow none of the fluid to enter the peritoneal cavity. If catch or tooth forceps are used, they should be placed above and below the opening of the trocar, so that if the tissues, which are often very thin, are bruised, the injured part may lie in contact with the parietal peritoneum. As soon as the wall of the bladder is drawn out through the wound, a free incision is made into it, the rest of the contents allowed to escape, the interior carefully sponged out, and the finger introduced to ascertain if there is any obstruction present. Loose calculi present no difficulty, but if they are impacted far down in the neck, or in the cystic duct, the greatest care is required to avoid injury. Sometimes they may be removed by special forceps, the surface being gradually nibbled away, while the stone is fixed by the forefinger of the other hand pressing against it from outside the duct. On one or two occasions the stone has been broken by pressure from the outside, forceps guarded with rubber tips being used to avoid bruising as far as possible. Needling has been recommended to break them up. The mucous membrane has been very carefully nicked from the inside. The calculus has been left and the fistulous opening syringed out constantly with warm water for a fortnight, and, finally, when everything else has failed, the gall-bladder has been excised.

In a few cases the wound in the gall-bladder has been successfully sewn up and the emptied sac returned into the abdomen, but Tait, who has performed more of these operations and with better success than anyone else, condemns this strongly. The walls are often exceedingly thin, it is very often impossible to make sure that the opening into the bowel is patent, and if any further operation is required it is decidedly advantageous to have the fundus of the gall-bladder adherent to the cicatrix. The walls of the sac, the parietal peritoneum, and the skin, should be accurately sewn together. Tait uses two continuous sutures, one for each side of the wound, the ends being tied together afterwards above and below. A large drainage-tube is inserted, so as, if possible, to carry all the bile away from the wound, and ordinary absorbent dressings are applied. When the wound is healed the drainage-tube may be withdrawn. If the obstruction has been removed the bile soon finds its way into the intestine again; if, on the other hand, this is impossible, a biliary fistula is left which may be dealt with later on.

Cholecystectomy, or removal of the whole gall-bladder, is a more serious operation, and should only be practised when, from the condition of the parts at the time of the operation, it is clear that incision and drainage either are impracticable or would fail to give relief. Sometimes this occurs after prolonged inflammation; the gall-bladder is so utterly disorganised that it is not possible to suture it securely to the abdominal wound; and it may happen in cases of impacted calculus, if it is not possible to extract or crush the stone without injuring the wall of the duct. The preliminary steps are the same; the gall-bladder must be separated from adhesions, all hæmorrhage carefully stopped, the peritoneal flaps united with a continuous suture, and the end of the cystic duct tied.

Surgical Diseases of the Pancreas

Large cysts, associated with obstruction of the main duct, are practically the only form of disease of the pancreas that comes within reach of the surgeon. They project forwards, either beneath the right lobe of the liver or in the left hypochondrium, pushing the stomach to the right, the spleen to the left, and the transverse colon downwards. In some cases fluctuation is very plain; in others there is communicated pulsation from the abdominal aorta, or the tumour moves up and down with respiration.

General emaciation is not uncommon; as it occurs even with small cysts it has been suggested that it may be due to interference with the solar plexus. There may be a sense of oppression or paroxysmal attacks of pain, deep between the ensiform cartilage and the navel, with a feeling of intense anxiety. Undigested muscular fibre may be present in the stools; vomiting is not unfrequent; the bowels are often very irregular, and sometimes at least the complexion becomes peculiarly earthy. The diagnosis can only be verified by aspiration. The fluid may be dark brown and turbid, like pea-soup, or the contents may be clear, or they may be mixed with pus or blood. In several cases the presence of similar ferments to those of the pancreatic juice has been ascertained by experiment. Hydatids of the liver and other organs, ovarian, mesenteric, omental, and renal cysts, dropsy of the omental bursa, and distension of the gall-bladder, closely resemble it, and, in many cases, have only been distinguished at the time of operation.

Extirpation may be practicable occasionally; in most instances, incision and drainage are to be preferred. The opening should be made over the most prominent portion of the tumour, the contents partially removed by aspiration, and the cyst drawn out and secured by sutures to the parietal peritoneum and the skin. If the discharge irritates the skin, boracic acid dressings should be used.

CHAPTER XIX

INJURIES AND DISEASES OF THE RECTUM

MALFORMATIONS OF THE RECTUM AND ANUS

OF these there are two chief varieties.

In the first the original cloacal outlet persists to a greater or less extent, and the bowel terminates in the bladder, vagina, or urethra.

In the second the communication with the genito-urinary organs is shut off, but the rectum does not open upon the surface; like the former, this is due to an arrest of development. The intestine is formed from the innermost of the germinal layers: at either end it terminates blindly, the anus as well as the mouth being developed by an invagination from the exterior. Consequently three degrees of defect are possible: the anus may be wanting, and the rectum well formed (the most common); the anus may be well formed and the rectum wanting (the most serious); or, finally, both may be present, but the septum between them persist, either as a definite membrane or as a mere epithelial layer.

Besides these, in exceptional cases, the orifice of the anus may be very small, and displaced, either forwards, or to one side, apparently by a growth prolonged forwards from the coccyx in the middle line of the perinæum.

The **diagnosis** is usually apparent at once. If, however, a distinct anal diverticulum is present, the malformation of the rectum may be overlooked until suspicion is aroused by distension, persistent vomiting, and the absence of meconium. The condition, if unrelieved, is nearly always fatal within a few days; a few cases have lived for some time, even years, with regular fæcal vomiting. An exception may be made in the case of a vaginal opening, as this may not be discovered until adult life. If there is a communication with the urinary passages, death is usually caused by cystitis and pyelonephritis.

Treatment.—The child must be held in the lithotomy position (especial care is required to keep it straight), a catheter passed into the bladder or vagina, according to the sex, and a thorough examination made.

In the slighter cases the bulging caused by the rectum when the child cries and the dark colour of the meconium are visible at once, and all that is required is to tear through or divide a thin partition, leaving a little oiled lint in the opening as soon as the bowel has emptied itself.

In most, however, either from the anus being absent, or from the thickness of the tissues between it and the bowel, a median incision must be made through the skin from the site of the anus to the tip of the coccyx, and the dissection carried backwards, guided by the catheter in front and the bone behind. If the bowel is near the surface it may be drawn down and sutured to the margin; but this is no good if there is much tension. In this case a stricture is almost sure to follow unless special precautions are taken, a catheter or the tip of the finger being introduced at first every day. After a time the tendency to contract appears to diminish.

If the rectum is not exposed in this way, firm pressure should be made upon the abdomen while the finger is in the perinæal wound; sometimes the end can be felt, or the bulging is so plain that there is reason to believe it is not far off, and then the dissection may be continued along the sacrum until the peritoneum is reached, the coccyx being resected if necessary. When this does not succeed the choice lies between inguinal and lumbar colotomy, preference being generally given to the former, not only on account of the more convenient situation of the anus, but because, when the lower part of the rectum is not developed, the rest of the large intestine is very likely to be displaced and inaccessible from behind.

Opening the peritoneal cavity through the perinæum has been advocated on the ground that it saves the risk of a double operation, and that as the external sphincter is usually present in these cases, the inconvenience of incontinence would be avoided; but the difficulty of recognising the character of the intestine at such a depth is very great, and the power of selection very small.

When there is a communication with the vagina a bent probe may be passed through it into the rectum as a guide; but it rarely happens that the opening is on the side of the bowel, with a blind pouch running beyond; nearly always it lies at the end. In this case, and also when the rectum communicates with the urinary passages, an anus must be formed, if possible in the natural situation, and the communication closed by a subsequent operation.

Examination of the Rectum

In many cases it is advisable to give an injection beforehand, so as to bring down the upper part of the bowel. The patient should lie well over on the left side with the hips and knees flexed, and the back to the light. The character of the skin and of the orifice of the anus is noted first, whether there is any discoloration, swelling, or abnormal opening. Then gentle pressure is made all round to ascertain if there is any induration or fluctuation, or any very tender spot, especially near the margin.

The mucous surface of the orifice is next inspected. The fingers are placed upon the buttocks, and, with the thumbs quite close to the anus, the sides are firmly separated while the patient strains down. Small ulcers and fissures at the margin, polypi, and internal piles can often be seen at once.

The finger is then introduced, well oiled, and the angles of the nail filled in with soap. The pulp should be placed over the orifice and the patient told to bear down; as the muscles relax they carry it in with them. If there is any evidence of fissure slight pressure should be made towards the opposite margin.

Except in the case of polypi, the marginal part of the mucous membrane is always examined first: painful ulcers, the orifices of fistulæ, &c., are in the majority of instances within an inch of the edge. Then the investigation is carried higher, the character of the surface ascertained, and, by deeper pressure, the condition of the neighbouring organs. By making the patient bear down, especially if he is standing, an inch or more of the rectum can be brought down on to the fingers; but in cases in which the disease is situated high up, or there is a difficulty of diagnosis, it is advisable to give an anæsthetic. When the muscles of the floor of the pelvis are well relaxed, the perinæum can be pushed in in front of the knuckles, and the finger can generally reach the promontory of the sacrum. If this fails, further examination may be carried out with the speculum, the long tube, or the hand.

The most convenient form of speculum is a short conical metal tube, open at the end and on one side; but this, of course, only exposes the part immediately inside the anus. If it is wished to inspect the deeper portion, the patient must be placed under an anæsthetic, in the lithotomy position, with the pelvis well raised so that the intestines may sink towards the diaphragm, and the sphincter be dilated. Metal tubes, then, of various sizes, may be very carefully introduced, the mucous membrane being lifted from off the opening from time to time with a sponge on a holder.

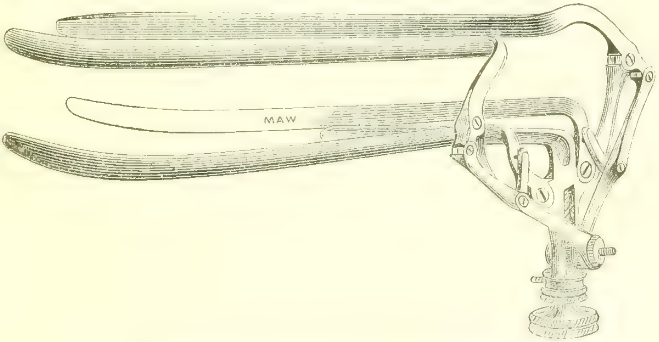


Fig. 387.—Allingham's rectal speculum.

Rectal bougies as a means for diagnosis are dangerous and misleading. They nearly always catch, either against the sacrum or behind some fold of mucous membrane, and very often give rise to the suspicion of a stricture where none exists. Enema-tubes are a little better, as by injecting fluid through them the mucous membrane may be lifted off from the end out of the way. Sometimes then the tube can be passed a few inches farther, proving that there is no stricture; but, if it cannot, no conclusion can be drawn.

Finally, the hand, provided it is under seven inches in circumference, can be introduced in most well-formed adults. The patient must be under an anæsthetic; the sphincter very gradually dilated; and then the fingers slowly wormed in with a screwing action until the broader part slips inside. Oil or vaseline should be freely used. I have on several occasions done this myself, and have found it once or twice of very great use in diagnosis. The proceeding is not without danger; there are several cases on record in which sudden death occurred, probably from rupture of the peritoneal band that surrounds the bowel. This can be felt like a cord passing across it obliquely, about four inches up, and it must on no account be forced. The sphincter, of course, loses its power for some days, but I have never found any permanent paralysis follow.

If the hand cannot be introduced, owing to the peritoneal fold, a combination of these two methods is very useful, the long enema-tube being passed up the palmar surface, and guided by the fingers into the smooth tubular portion above.

Injuries of the Rectum

Lacerations of the margins of the anus are occasionally caused by the passage of hardened fæces, or by the rough use of enema-tubes, and sometimes they degenerate into very painful ulcers. The anus, too, may be torn in parturition, the perinæum giving way completely.

Foreign bodies of all sorts occur from time to time, some, such as fish-bones, enteroliths, gall-stones, &c., coming down from the bowel, others introduced from below ; and it may require very great ingenuity to extract them without inflicting serious injury.

Hæmorrhoids

The veins that surround the lower part of the rectum are exceedingly liable to become distended and varicose. Sometimes they remain in this condition ; more frequently, owing to the congestion and œdema, and from the constant irritation to which they are subjected, the cellular tissue around becomes inflamed ; the lymph that is poured out becomes organised, and at length distinct tumours, known as hæmorrhoids, are formed. These may be classed as external, internal, or intermediate, according to their situation under the skin, under the mucous membrane, or partly under the one, partly under the other.

Their frequency is due to the structure of the part. The hæmorrhoidal plexus lies under the mucous membrane, inside the margin of the anus, and a short distance up the bowel. The blood from this returns partly by the superior hæmorrhoidal veins, which commence close to the edge, and run up in the sub-mucous layer before piercing the muscular coat ; partly by the middle and inferior ones which end at length in the internal iliac. Of these the first are by far the most important ; the others merely drain the anal margin and the region of the external sphincter ; and the communication between the two is so poorly developed that it is of little use in affording relief; an injection thrown into the hæmorrhoidal plexus through the inferior mesenteric does not pass on into the iliac veins. This plexus, therefore, lies at the root of the valveless portal system, and feels the strain first and most severely when anything impedes the flow of blood upwards through the abdomen and liver.

Another point is that while the veins of the rest of the abdomen are supported by the walls, and prevented from becoming distended when the muscles of the abdomen contract, the hæmorrhoidal plexus is entirely unprotected, and, owing to the peculiar laxity of the tissue in which it lies, is quite incapable of resisting the increased blood-pressure. Straining or bearing down, if there is the least dilatation, makes the veins swell out at once, and the mucous membrane becomes purple. This, of course, subsides again as the muscles relax, but it can easily be understood how the frequent repetition slowly but surely makes the dilatation worse and worse.

Verneuil attributes much importance to the superior hæmorrhoidal veins passing through valvular openings in the muscular wall of the bowel a short distance above the anus, believing that the contraction tends to constrict them and check the flow. If, however, this were the case, it would equally relieve them from the backward pressure of the blood higher up in the portal system.

The exciting causes are of the most varied description. Every impediment to the return of the blood helps: valvular disease of the heart; chronic bronchitis and emphysema; cirrhosis of the liver; abdominal tumours; pregnancy; accumulation of fæces; everything in short that directly or indirectly checks the flow towards the heart.

Constant straining, whether arising from constipation or from causes connected with the urinary tract, calculus, stricture, or enlarged prostate, acts in the same way, perhaps more rapidly.

Active congestion, such as arises from the repeated use of unsuitable purgatives, over-indulgence in alcohol, sexual excesses, and, in women, from uterine or ovarian affections, often brings them on. Still more frequently it precipitates an acute attack, and is the immediate cause of the patient applying for relief.

Whether hereditary influence has any effect of itself, as distinct from that which is due to the same habits and the same mode of life, is very doubtful. Few people attain old age without some enlargement of the hæmorrhoidal veins: this is the natural result of the anatomy of the part. In the majority of cases, unless there is some additional reason, causing hyperæmia for some considerable time, and leading either to inflammation or to chronic congestion and œdema, the consequences are not sufficiently serious to make them apply for relief.

External hæmorrhoids differ from internal ones in so many respects that it is advisable to deal with them separately. There is rarely any difficulty in distinguishing one from the other. The former are covered with skin, and, unless there is a large thrombus in some superficial vein, are some shade of pink, according to the pigmentation present and the degree of inflammation. Moreover, they cannot be returned into the bowel by pressure. The latter are covered with mucous membrane: their surface is soft and smooth, and their colour bright red or purple. If they have been prolapsed for some time they become dry and rough; but they can always be returned as soon as the sphincter is relaxed.

Intermediate ones, partly subcutaneous, partly submucous, with the white line that marks the junction of the two surfaces passing over them, are very common. Clinically they resemble internal ones in most of their features.

External Hæmorrhoids

These begin as dilated veins around the margin of the anus and form soft livid swellings which disappear on pressure and grow firm and hard when the patient strains. As such they may last for an indefinite time without the least inconvenience. Sooner or later, however, chronic congestion and œdema set in; lymph is poured out into the cellular tissue; the veins are obstructed; and then, as the exudation becomes organised, the skin grows out into thickened irregular folds, which when once developed are permanent. These are sometimes called cutaneous piles.

When these are irritated or become inflamed, all the symptoms are aggravated. In some cases the central vein is plugged with a thrombus; and a hard and tender knot, dark purple in colour, forms in the centre of the pile. In others the cellular tissue is chiefly concerned; the pile becomes many times its former size: and the skin over it grows tense and pale from the amount of fluid it contains. Very often, just inside the anus at the base of the pile, there is a small crack or abrasion from which the inflammation starts. In severe cases the whole circumference is involved, so that the opening seems buried in the centre of a swollen ring. When the vein is primarily affected the pile is sometimes called *thrombotic*; when it is chiefly the skin and cellular tissue, *œdematous*; but in many instances it is impossible to distinguish them.

Symptoms.—In the slighter cases there is merely a sense of heat and irritation about the anus, with itching, especially at night. Defæcation is attended with a certain amount of pain, and there is rather a tendency to strain; but, so long as the bowels are moderately relaxed, there is little more than discomfort in the intervals between the motions. When the inflammation is severe, the pain may be intense, especially if the part is touched, and while the bowels are acting; in some cases it is almost as bad as in fissure, though it rarely lasts so long. The throbbing is constant; there is a persistent sense of fulness; the sphincter is in a state of spasmodic contraction; and, if the bowels are confined, the straining and tenesmus scarcely cease. Sometimes the constitutional disturbance is very severe, and in nervous, excitable people, there may be a high degree of fever. Suppuration is not uncommon, and although the abscesses are superficial, and break soon, they may leave troublesome fistulæ behind them.

Treatment.—If the case is seen before the inflammation is severe, the symptoms are easily relieved. The patient must remain quiet, as much as possible in the recumbent position; walking is painful and very injurious; the diet must be restricted; no stimulants or highly seasoned food allowed; and the bowels kept open with sulphate of magnesia or some appropriate mineral water. Small doses of calomel, or of podophyllin with taraxacum, may be given with advantage. A warm bath should be taken night and morning, and the skin around the anus should be kept supple with a mild astringent ointment, of calomel, lead, or nitrate of mercury.

When there is evidence of thrombosis or of suppuration more active treatment is required. If there is a small hard lump, like a foreign body, in the centre of the pile, it should be transfixed, the clot turned out, and the vein allowed to bleed. Afterwards it may be left to granulate up. Large œdematous piles usually shrink up of themselves as soon as the fissure or excoriation on which they depend is healed. Afterwards, if thickened folds of skin are left around the anus, they may be removed with scissors curved upon the flat; but care should be taken not to cut them off at the base, for fear, when the wound heals, that the contraction may cause a stricture.

INTERNAL HÆMORRHOIDS

Of these there are two chief varieties—the sessile or capillary, and the venous or pedunculated. Not unfrequently they occur together, and probably they are really due to the same cause; but there is sufficient difference in their symptoms and treatment to warrant a separate description.

1. *Capillary Hæmorrhoids*

These scarcely project above the surface; they are never extruded from the anus unless dragged down by pedunculated ones; and the veins are not much dilated. The capillaries and minute blood-vessels are chiefly involved;

the submucous tissue is a little thickened; the epithelium is thinned and detached in places; while the mucous membrane is converted into a soft, spongy network of dilated vessels, so that it stands out from the smooth even surface around like a bright red patch of florid granulations, which bleed at the slightest touch. It has been compared in appearance to a raspberry.

2. *Venous Hæmorrhoids*

These, like external ones, are at the first merely varicose veins. If the finger is introduced into the rectum, all that can be felt is a soft smooth swelling under the mucous membrane, which disappears with the least pressure, and grows rather more firm when the patient strains. In many cases it is more easy to see than to feel them: if the rectum is washed out with a warm injection and the patient is directed to strain down, as the mucous membrane becomes everted, the veins gradually swell up and stand out like lobulated bluish masses. After a time, if the congestion continues and becomes chronic, the tissue around them becomes thickened; they grow firmer and more solid; a sense of resistance is experienced by the finger; they stand distinctly above the surface, and no longer disappear when touched; and at length they develop into definite tumours.

As soon as this occurs, owing to the constant irritation to which they are exposed, the mucous membrane over them becomes thinned and ulcerated. Inflammation sets in; lymph is poured out; the neighbouring blood-vessels, arteries as well as veins, dilate; and at length, as the exudation becomes organised, real fibrous tumours are formed, springing from the submucous layer, filled with varicose veins, and not unfrequently containing arteries of very considerable size, which they have dragged down with them. In many instances there are three or four of these, well inside the anus, some still sessile, others pedunculated, and hanging by stalks of various sizes.

The mucous membrane covering them does not retain its smooth and soft appearance for long. Very soon it becomes affected by the continued irritation; sometimes it is roughened and covered with florid granulations, as in capillary piles; more often it is thinned and ulcerated, so that the deeper tissues, perhaps the veins themselves, are exposed; here and there along the under surface it grows thick and dense. In older cases, in which the piles protrude from the anus, it becomes changed beyond recognition. Where they only descend at long intervals and return easily of themselves as at the first, the surface may still be bright and smooth, though deeply congested; but if they protrude frequently it is sure to become inflamed and ulcerated, or converted by the continued friction into a dry, hard substance, almost like leather. When in this condition it is not always easy to distinguish it from skin.

Piles that protrude are always in danger of being caught and held, so that it is difficult to return them. The sphincter is in a state of painful spasm; the neck of the pile is tightly constricted; congestion and strangulation follow; and unless it is soon released the protruding part may become gangrenous. A large inflamed purple mass projects from the anus, surrounded by a broad band of everted muscle and mucous membrane. The skin all round is inflamed; the surface of the pile is greenish-black in colour; the mucous membrane sloughs; and sometimes the whole mass perishes and is cast off. Occasionally a natural cure is effected in this way; much more often part only is lost, and the rest is retracted inside the anus.

Symptoms.—The only direct symptom of *sessile piles* is hæmorrhage, but this may be so profuse and so constant, occurring on every occasion when the bowels act (though not only then), that the patient becomes absolutely blanched. There is no protrusion or pain unless the vascular patch is near the orifice ; but life itself may be endangered, and, in most cases, the loss of health and strength is utterly out of proportion.

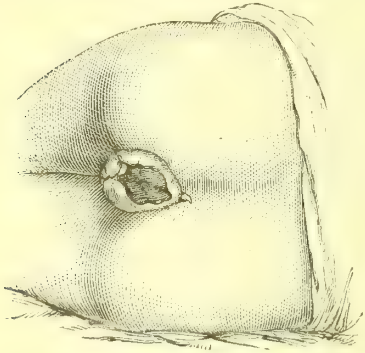


FIG. 388.—Internal hæmorrhoids.

In the *pedunculated* form bleeding is less constant and the amount more variable. At first there is merely a stain; later the blood may drip for a few minutes after every action of the bowels; occasionally it is profuse and comes in jets through a small opening in the wall of a vein, the spasmodic contraction of the muscles making it shoot out as if an artery had been divided.

At first the piles return into the bowel at once, either of themselves or when the patient lies down, with an immediate sense of relief. In a little while, however, it requires pressure to get them back ; there is a deep throbbing pain, extending up the back and down the thighs; the sphincter is in a state of spasmodic contraction, the rectum feels as if it were distended to its utmost, and every attempt at procuring relief only makes the condition worse by the straining that accompanies it. Even when they are replaced it is some time before the patient is comfortable again. Sometimes, in these cases, they become strangulated and slough ; the symptoms grow more and more severe ; the parts around the anus are acutely inflamed, the inguinal glands enlarge, there is a very considerable degree of fever, and then, after the slough has separated, the inflammation gradually subsides. Sometimes, on the other hand, the sphincter loses its power and becomes relaxed ; the severity of the symptoms diminishes, but the piles are constantly down. They descend on the least exertion, and at the most inconvenient times ; there is a constant and most annoying discharge of mucus ; the skin around the anus becomes sore and covered with vegetations ; the mucous membrane at length becomes prolapsed as well ; and, in cases of long standing, there may be total inability to retain loose motions, or flatus.

Diagnosis.—External piles present no difficulty : condylomata, vegetations, cancerous nodules and other growths around the anus can be distinguished at once. Internal ones, at the first commencement, when there is nothing but a varicose condition of the veins, may escape notice unless digital examination is carefully conducted ; the soft loose folds of mucous membrane are emptied with the least pressure and disappear ; but if the patient is directed to strain down, or if the mucous membrane is gently everted after a warm injection, there can be no mistake. Later, when they protrude, it is sometimes difficult to distinguish them from prolapse of the mucous membrane, with which they are often associated ; in the one, however, the protrusion is irregular in shape, and covered over with bosses ; in the other it is smooth and uniform.

In all cases of hæmorrhoids, external as well as internal, it is very essential that a thorough examination should be made, not only of the rectum, but also of the neighbouring organs; otherwise the cause may be overlooked while a symptom is being treated.

Treatment. 1. *Palliative.*—In the early stages this may be efficient of itself; in the later, and after operations, it is no less essential to prevent piles already present becoming worse and others forming.

Diet demands the greatest care. Meals should be as sparing as consistent with health; all highly seasoned dishes, and alcohol, especially beer and heavy wines, strictly prohibited, and the allowance of meat limited. A fair amount of exercise must be taken, but long railway journeys should be avoided. The bowels must be made to act regularly every day, and the motions kept as soft as possible. Confection of senna, Friedrichshalle water, compound liquorice powder, or other laxatives may be taken the first thing in the morning. After each motion the rectum should be washed out with cold water, or with a weak astringent, to brace up the mucous membrane and constrict the walls of the vessels. If the piles come down they may be smeared over with an ointment of sulphate of iron or some other mild astringent before returning them. If they do not, a similar preparation, or the ointment of galls and opium, may be introduced, either as a suppository, or with one of the special instruments devised for the purpose. Bleeding, when it comes from a capillary pile, may be checked in the same way; but if it persists a more efficient application is desirable. In all cases careful enquiry should be made that there is no latent cause at work, especially connected with the urinary organs in men, and the uterus and ovaries in women.

2. *Radical.*—If the hæmorrhage persists or is severe, even for a short time; if the piles are large and fibrous, so that they form distinct and solid tumours, or if they are constantly descending, or constantly giving rise to pain and inflammation, something further is required.

Inflamed and prolapsed piles may be returned and the sphincter dilated, operation being postponed until the sloughs have separated; but in most cases there is no reason why, if the patient consents, they should not be dealt with at once.

Operations should not be performed during pregnancy or shortly after parturition, an exception being made in the event of hæmorrhage; nor should anything be done if there is a definite local cause, such as displacement of the uterus, stricture of the rectum, carcinoma, enlargement of the prostate, or other affections of the urinary organs. This must first be relieved; then, if the piles persist, something may be done for them; otherwise healing is delayed, and rapid recurrence is sure to take place.

A very great variety of operations have been devised for internal hæmorrhoids; some of them have been invented over and over again, sometimes with, sometimes without, slight modifications; but many are only used in special cases. For all alike the patient requires preparation. The large intestine must be emptied, and the bowels made to act freely before the operation. As a rule, it is sufficient to give a dose of castor oil the night before, and an injection the morning of the operation; but if the patient has been living freely, and the liver is congested, small doses of calomel or blue pill, followed up with some aperient mineral water in the morning, may be given for several days previously. An anæsthetic is necessary in all but the most trivial cases (in which cocaine suffices) and where carbolic acid is injected. Generally, it must be given freely, as the anus retains its sensitiveness longer than almost any other part of the body.

For all but Whitehead's operation, for which the lithotomy position is preferable, the patient should lie upon the side, with the back to the light and the knees well drawn up; and the table should be of a convenient height. The upper buttock is raised by an assistant, who also prevents the legs being straightened out.

1. *Dilatation*

Simple dilatation may prove an effectual cure when the piles are recent, especially if there is much spasm or hypertrophy of the sphincter, such as is often combined with ulcer or fissure of the rectum. In other cases, in which a more serious measure is inadvisable, it often gives great relief; and (unless the muscles are relaxed already) it is always a most useful addition to ligature and other operations, preventing spasmodic contraction afterwards. It should be done with the hands only; no instrument is required. The thumbs are inserted into the rectum, taking care to introduce them sufficiently far to catch the whole of the sphincter; and the anus gently dilated, first in one direction, then in another, until the contraction is thoroughly overcome and the muscle feels soft and pulpy. The skin is not torn, but bruising is generally apparent afterwards. The patient should be kept in bed for two or three days, on light diet, and if there is much soreness about the part a morphia suppository may be given; but care must be taken that the bowels are not confined. At the end of that time he may be allowed to sit up, and it will be found that the veins have relieved themselves and to a great extent recovered their tone. It must not be forgotten, however, that, if the same causes are allowed to continue, and the bowels are not carefully attended to, the symptoms are sure to return.

2. *Injection of Carbolic Acid*

is of very limited application. Its chief merit is that it is not necessary to confine the patient to bed for more than one day; but it is very uncertain; it may produce too great an effect or too little; and as it is necessary, if the piles are numerous, to repeat it again and again, the benefit is more than doubtful. Three or four drops of a strong solution of carbolic acid (gr. x, ad ʒij) are injected with a hypodermic needle right into the centre of the pile, taking care not to allow any to come in contact with the surface. It swells up immediately and must be returned at once. There is little pain, and in many cases, as the inflammation subsides, the pile gradually shrivels up and disappears. I have tried it on several occasions, and no doubt it is effectual in the slighter cases, for a time at least; but it is not a radical operation in any sense of the term.

3. *Application of Acids*

Sessile piles, when there is a bright granular patch of mucous membrane which bleeds at the least touch, can be cured in this way; for all other forms it is useless. Nitric acid or the acid nitrate of mercury is generally used; but chromic acid and strong carbolic acid have been recommended. The patient must be anæsthetised; the sphincter stretched and the patch well exposed with a speculum. The surface is then dried with cotton-wool, and the acid painted over it with a glass brush, taking care that none comes in contact with the skin or the margin of the anus. Any excess should be mopped up at once. A morphia suppository is introduced afterwards to prevent pain and spasm, and the speculum withdrawn. A superficial slough usually comes away in the course of a few days without being noticed, and the granulating surface left contracts and obliterates the deeper part of the vessels.

4. *The Actual Cautery*

This may be used in two ways. In one the pile is drawn down, seized with a clamp (the surface of which is faced with ivory or some other non-conducting substance), and tightly compressed. The projecting portion is then cut off; the clamp unscrewed, and each point as it bleeds touched with the cautery at a dull red heat. As soon as the whole surface is seared the clamp is removed and the process repeated upon another. This has been strongly recommended, but it is more liable to secondary hæmorrhage than a ligature properly applied; and it is not easy to control the extent of mucous membrane that is destroyed. The cicatrices left by burns are notoriously prone to contract and become rough and irregular afterwards. In the intermediate form of pile it certainly should not be used, as the actual cautery applied to the skin is excessively painful.

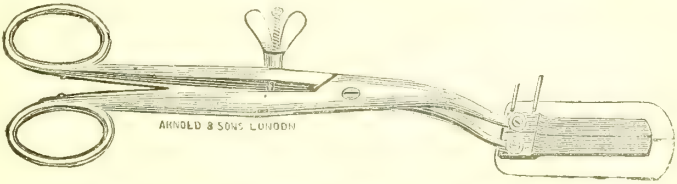


FIG. 389.—Clamp with parallel blades for use with the cautery.

In the other method a pointed iron or platinum cautery (Paquelin's is the most convenient), at a white heat, is thrust quickly into the centre of a pile, allowed to remain a second or two and then withdrawn. There is no hæmorrhage and very little inflammation. This method is scarcely applicable to piles of any size, but where one or two small outlying ones are left after ligature, and it is not considered advisable to take up any more mucous membrane, it answers very well.

5. *Crushing*

In this the base of the pile is seized in a clamp, the edges of which are bevelled to prevent cutting through, and crushed by means of a screw. The anus must be dilated first; the pile drawn down, and the instrument applied so as to avoid injuring the skin. The projecting part is cut off, and the clamp unscrewed, after keeping up the pressure for at least two minutes. For small detached piles there is no doubt this method is very valuable. If the pressure

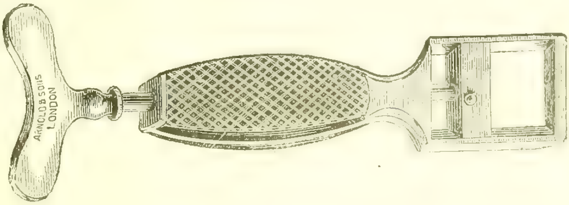


FIG. 390.—Screw clamp for crushing piles.

is maintained for a sufficient time there is little risk of hæmorrhage: the wounds heal more quickly than after ligature; and in most cases the pain, when the bowels act for the first time, is less; but, especially in the case of broad-based vascular piles, care is required to prevent the mucous membrane being too much involved.

6. *Ligature*

For all ordinary cases ligature is safe and effectual; it may be applied to every form of pedunculated pile, though, as already mentioned, one or two varieties are capable of being treated at least as well in other ways.

The sphincter is dilated; the most prominent pile seized and drawn down with vulsellum forceps, and an incision made three-quarters around its base with a pair of sharp spring scissors. The portion left is the mucous membrane that comes down from the bowel on to its upper surface; if there are any large vessels, especially arteries, in the pile, when it is drawn down in this way, they lie close beneath this. The cut, therefore, runs along the white line between the skin and the mucous membrane, or just above this, and up each side of the base, parallel to the bowel. A well-waxed piece of whipcord is now placed at the bottom of this groove, and tied high up as tightly as possible. The first knot should be a double one, to prevent slipping.

Two, or perhaps three, sets of piles may require tying in this way. If they are very large the strangulated part may be cut of, but care must be taken to leave enough to prevent the ligature slipping. Any external or intermediate piles left should be dealt with at the same time, or they are very liable to swell up and become inflamed. Finally, a morphia suppository is introduced to prevent straining, and a T bandage with a firm pad placed over the anus. The patient should be kept in bed for at least a week, on light diet, and the bowels prevented from acting for four or five days; at the end of that time, if they do not move of themselves, a full dose of castor oil may be given, or a compound colocynth pill, followed next morning by an aperient draught. The first action of the bowels is always painful, and it is essential to avoid straining. The ligatures usually separate and come away about the fifth day, leaving comparatively small granulating surfaces.

If all goes well, the patient may be allowed to lie upon a sofa at the end of a week or ten days. The anus should be sponged with warm water and some mild antiseptic every night and morning; or, as soon as the patient can sit up, a warm hip-bath may be taken once a day. If there is much inflammation about the part, a pad wet with lead lotion may be kept upon it; or, if this fails, hot fomentations may be tried. The wounds generally heal readily, but the recumbent position is essential. A mild astringent ointment may sometimes be introduced into the rectum with advantage after the ligatures have separated.

7. *Excision* (*Whitehead's Operation*)

The anus is dilated; an incision is made through the mucous membrane just inside the orifice all the way round; the sphincter is exposed; and the mucous membrane, with the attached hæmorrhoids, is stripped from the muscles beneath, until the whole pile-bearing area is detached and can be brought outside. This dissection (except above and below) may be readily managed with the closed scissors, without any serious hæmorrhage. The upper part should, of course, be left to the last. As soon as this is thoroughly separated, the lower end of the projecting tube, with the hæmorrhoids attached to it, is cut off transversely bit by bit (the arteries being tied or twisted as they are divided), and fastened with sutures accurately to the divided edge just inside the anus. Union ought to take place by the first intention.

Where there is a ring of veins forming a varicose plexus all round the inner margin of the anus, this method is most effectual, and it possesses the merit of being thorough. It is not probable, however, that the percentage of relapses after ligature, if the operation is properly performed, is very much higher; the cicatrisation that follows tends, in a marked degree, to constrict the rest of the blood-vessels and support the mucous membrane; and there is no comparison as to the relative facility of the two proceedings. Whitehead's may secure union by the first intention; but, if this fails, and the mucous membrane retracts, a granulating sore is left, extending all round the bowel, and this is not unlikely to leave some constriction behind it, though it is only fair to say this has never occurred in Whitehead's practice.

Complications after Operation

Retention of urine is exceedingly common. In a few instances it can be relieved by loosening the bandage and applying warm fomentations to the pubic region; but as a rule it requires a catheter, and sometimes this continues necessary for ten days or a fortnight.

Recurrent or secondary hæmorrhage may be very serious. A little oozing is not uncommon a few hours after the operation, and again when the ligatures separate; but sometimes a large vessel gives way, or the tissues are so soft and vascular that blood seems to pour out from the whole surface. There may be no external sign for a long time; the patient complains of feeling faint and of a desire to go to the closet; there is a moment's straining, and an immense quantity of blood-clot is suddenly poured out. Slight hæmorrhage may be checked by placing small lumps of ice in the rectum, or by washing it out with ice-cold water. If, however, there is any considerable loss, the patient must be placed under an anæsthetic, and the bowel thoroughly explored, the mucous membrane being pulled down bit by bit through the dilated anus. Sometimes the bleeding point can be seized with pressure-forceps, or it is possible to apply a ligature; in many cases, however, either it cannot be found or the tissues are too soft to hold, and the only means of arresting the hæmorrhage is to plug the rectum. This is best done with a tampon, similar to that used after lithotomy, only much larger. There is a central tube through which flatus and liquid fæces can escape, and around this a very soft distensible rubber bag, which can be dilated to almost any extent by injecting air or water. If this is not at hand, a conical sponge, with a double ligature passed through the apex, may be used, as Allingham suggests. The point of the cone is thrust at least five inches up the bowel, leaving the ends of the ligature hanging out; the whole of the space beneath is plugged with cotton-wool powdered over with alum or sulphate of iron, and then the apex of the sponge is pulled down by the ligature, while the cotton-wool at the same time is thrust upwards with the fingers, so as to spread the intervening substance out and press against the walls.

Contraction at the orifice may be caused by removing external hæmorrhoids too freely; and sometimes the same thing occurs an inch or two inside the anus. For this reason it is always advisable to examine the bowel with the finger during the process of cicatrisation. It is said to be most common after the application of the cautery.

The opposite condition—loss of tone in the external sphincter—is not uncommon in cases of long standing. Usually it recovers of itself; but it may be assisted by washing out the bowel with cold water after each motion.

If there is much suppuration, or if the patient is allowed to get about too soon, fissure, fistula, or troublesome ulceration may follow. Occasionally there is a certain amount of tenderness about the inguinal glands.

Pyæmia and tetanus are occasional causes of death. The former may be due to the objectionable plan of transfixing the base of a pile so as to tie it in two halves. The latter is said to have been caused by the ligature involving a nerve at the orifice.

Prolapse of the Anus and Rectum

Protrusion of the mucous membrane only is known as prolapse of the anus. In prolapse of the rectum all the coats of the bowel are involved, mucous, muscular, and, when it is of any size, peritoneal as well, the recto-vesical or rectovaginal fold being dragged down until it forms a hernial sac; the one, however, is merely an exaggeration of the other. The mucous membrane is always everted to a certain extent during the act of defæcation, returning as soon as the pressure is removed; if an unusually large amount is protruded, it is caught and held by the sphincter, the submucous tissue stretching so that one layer glides upon the other. When this occurs repeatedly, and the sphincter and levator ani are too weak to prevent it, the muscular coat is at length dragged down as well, and the prolapse becomes complete.

Prolapse of the anus only is never of great size: there is merely a ring of mucous membrane surrounding the anus, and directly continuous with that covering the sphincter. If it is recent, it retains its normal colour and bright appearance; but it may be dark and congested, even purple or black, and sloughing. In old cases it becomes dry, and the surface rough and granular from friction.

Prolapse of the rectum, on the other hand, may protrude five or six inches, forming a great cylindrical mass, wide at the base and tapering more or less abruptly towards the orifice. Congestion and sloughing sometimes occur, but, owing to the sphincter soon losing its power, they are not common. On the other hand, the mucous membrane, especially near the base, is very liable to become hard and dry, like leather, from the constant exposure and friction. The hernial sac, when it is present, always lies in front; in old cases it attains a considerable size, and alters the axis of the bowel so that the orifice looks backwards towards the sacrum, instead of vertically downwards or a little forwards.

Causes.—The immediate cause is persistent straining, whether this is occasioned by diarrhœa, by hæmorrhoids or polypi, or by affections of other organs, phimosis, vesical calculus, stricture of the urethra or enlargement of the prostate. The natural eversion grows more marked, until at length it becomes a prolapse ; but this does not take place until the muscles that support the mucous membrane are exhausted and the tissue stretched. In children prolapse is exceedingly common ; the sacrum is straighter in them than it is in adults, their tissues are weaker and more delicate ; and probably the way they are left to strain at stool for an indefinite time is of considerable help. Summer diarrhœa, from its weakening effect, and from the constant straining, is the most common cause of all.

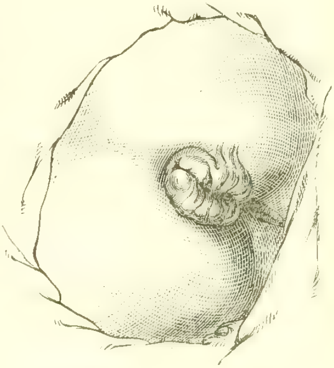


Fig. 391.—Prolapsus recti.

Prolapse of the rectum rarely occurs until the sphincter and levator ani have lost their power, whether this arises from neglect, the muscles having at length become overstretched, or from other causes, debility, prolonged residence in hot climates, or, in women, loosening of all the parts around the perinæum, consequent on repeated pregnancies. In some cases the weakness appears to be congenital, for prolapse of the rectum may occur in young adult life without any definite cause. In the worst form the anus becomes so wide and loose that the hand can be introduced into it with ease ; no trace of a sphincter is left ; and the bowel descends every time the patient coughs and strains.

Symptoms.—These depend more upon the condition of the sphincter and the tightness of the constriction than upon the amount of bowel that lescends. In chronic cases, in which the prolapse is the result of muscular weakness, and is constantly coming down, there may be extreme inconvenience and discomfort, but there is no constitutional disturbance. The parts are constantly moist with an offensive discharge : bleeding is not uncommon from the irritation of the mucous membrane ; the skin around is excoriated and grows out into loose pendulous folds, radiating from the anus ; sitting lown or walking is attended with pain, and the patient's health and strength are seriously impaired, but there is little or no fever. When, however, the prolapse is tightly nipped, the symptoms are much more striking, especially f the whole wall of the bowel comes down. There is a hot burning pain bout the anus ; it feels as if there was a foreign body inside ; the mucous membrane is swollen and livid ; ulceration and even sloughing may occur ; he discharge is intensely fœtid ; the parts around are hot, œdematous and wollen, and violent throbbing pain and high fever may set in. Actual angrene from the tightness of the constriction is unusual, but a considerble extent of mucous membrane may slough, and leave a dense and nyielding stricture.

The **diagnosis** is not difficult. It may be confused with hæmorrhoids r polypus, but the shape is distinctive. Not unfrequently they are present s well, and cause the prolapse by dragging the mucous membrane, and then he muscular coat, down with them. Intussusception of the rectum may e distinguished by the deep sulcus that surrounds the protrusion ; in true rolapse the finger cannot be passed into the anus by the side for more than n inch ; there is no break between the mucous surface and that of the phincter.

Treatment. *Prolapse of the anus.*—The cause must be removed at once, whether it is diarrhœa, phimosis, calculus, oxyurides, or anything else that induces straining. The protrusion itself should be washed with cold water or with a mild astringent lotion (ferri sulph. gr. ij ad ℥j), and returned with gentle pressure; in very bad cases it may be necessary to give an anæsthetic and slowly empty the blood-vessels of the part; and then the nates must be drawn together with a broad piece of strapping passing from one to the other. Afterwards the patient must not be allowed to sit and strain at stool: the motions must be passed in the recumbent position, and during the act of defæcation the orifice of the anus must be kept tense by one buttock being drawn away from the other. Tonics, good feeding, and cod-liver oil are generally requisite as well, for the children in whom this occurs are nearly always either weakly and delicate or pulled down by severe illness.

If this fails nitric acid may be tried: an anæsthetic must be given, the protrusion dried, and brushed over with strong acid, care being taken that none comes in contact with the skin. Then the part must be returned, a small plug of cotton-wool being left in the rectum, and a large pad placed over the anus and held firmly in position with strapping. The bowels must be kept confined for four or five days, the patient being in bed, and when they are allowed to act, every precaution must be taken to keep the motions soft and to prevent the sphincter yielding again.

If hæmorrhoids are present they should be removed; and sometimes the constriction of the mucous membrane and the organisation of the lymph effused effect a cure. Should however the whole of the prolapse be covered with a network of varicose veins, as it often is, it is better to perform Wheelhouse's operation at once—excise the affected part, and suture the lower end of the tube of mucous membrane to the anal orifice.

Prolapse of the rectum.—This is much more serious, not only from the local condition, the enormous dilatation of the lower part of the bowel and of the anal orifice, but from the state of health of the patient. Many of these cases occur in women past middle life, who have had large families, and who are suffering from obesity and fatty degeneration of the heart, or chronic bronchitis; and for such only palliative treatment is available. An abdominal belt, with a rubber pad made to fit over, but not in the orifice, is the most useful, and, if careful attention is paid to the condition of the bowels, is usually sufficient, as these patients are, for other reasons, seldom able to undertake much exertion.

In younger subjects excision or cauterisation may be advised. The patient is placed under an anæsthetic, in the lithotomy position, and the prolapse pulled down and held with vulsellum-forceps, or with a ligature passed through the apex. Then either triangular portions of the mucous membrane (the base of the triangle being within half-an-inch of the sphincter), are dissected up and removed, the edges being brought together with sutures afterwards, or four or six longitudinal stripes drawn with the cautery from base to apex, avoiding the large veins that lie upon the surface. Allingham recommends, in addition, that the sphincter should be divided on both sides with the hot iron, so as to ensure contraction of the orifice. Of these two methods the cautery is to be preferred, partly from the risk of hæmorrhage not being so great, but mainly because the cicatrices left are so firm and rigid. The contraction not only narrows the bowel, but, to a certain extent, shortens it as well, protecting it from further descent; while the sphincter, having a better and a firmer base to act from, not unfrequently regains some of its former power.

After the operation a small plug of oiled lint is inserted; the bowels are confined for a day or two, and then kept gently relaxed. The patient is not allowed to get up until the wounds are thoroughly healed; and for some time after that it is advisable that all motions should be passed in the recumbent position.

In slight cases this generally succeeds, and if sufficient care is taken, there is no relapse. Unhappily the same causes usually continue at work: the constricted extremity of the gut gradually yields; and at length the prolapse returns. Under these circumstances the only hope of permanent cure lies in shortening the rectum. The patient is prepared in the same way, two ligatures are passed through the apex of the protrusion, not only to make the bowel tense and hold it in any required position, but to prevent retraction when the tube is divided and the weight of the part taken off. A transverse incision is made through the anterior layer of the prolapsed mass half-an-inch below the skin line, until, if there is any peritoneum present, its outer surface is exposed. If it is not very extensive the hernial sac is detached from its surroundings and pushed upwards out of the way, to avoid opening the peritoneum; if it is too large the opposing surfaces are carefully sutured together before anything further is done. As soon as this is secure the inner tube is opened by a transverse incision corresponding in length to the size of the peritoneal pouch, and the cut edges of the muscular and mucous coats of the two tubes accurately fastened with a double row of sutures. The posterior half of the circumference is then divided, and sutured in the same manner, and the whole prolapsed portion detached. The vessels, which are often numerous and of considerable size, lie for the most part in the posterior half.

A similar operation has been performed in intussusception when the invaginated part protrudes from the anus.

Polypus of the Rectum

The term polypus is used in a general way for almost any outgrowth from the mucous membrane that projects into the cavity of the bowel. It should be pedunculated, but it may be sessile, provided the base is relatively small; and it may either be a new growth altogether—adenoma or fibroma—or a mere overgrowth of the normal tissue of the part. Generally polypi are single, growing within a short distance of the anus, from the dorsal surface of the bowel; but sometimes there are two or three, and in a few instances there have been hundreds. As a rule, their size is not great; the fibrous ones are seldom larger than a walnut, and adenomata in most instances are not so large; but when there are two or three together, they have been known to block up the interior, and give rise to symptoms of obstruction.

The soft or glandular polypus is most frequent in children. It is generally about the size of a raspberry, bright red in colour, smooth or slightly granular on the surface, and bleeds at the least touch. It is composed mainly of tubules lined with columnar epithelium, like Lieberkühn's follicles, held together with a little delicate connective tissue, and dilated in places into cysts; sometimes there is a little more fibrous tissue, and occasionally a few unstriped muscular fibres. At first they are sessile, but as they rarely give rise to symptoms until they protrude from the anus, a long and slender pedicle is generally present by the time the diagnosis is made.

Fibrous polypi, on the other hand, are rare except in adults. They spring apparently from the submucous layer, and are composed of fibrous tissue, which may be so hard as to creak when divided with a knife. It has been suggested that they are really adenoid polypi, which in course of time have become hardened and condensed by constant irritation. Occasionally it is almost impossible to distinguish them from internal hæmorrhoids.

Besides these, polypoid outgrowths of mucous membrane, hypertrophied from persistent irritation, are often present in cases of fissure just inside the anus.

Symptoms.—These are not definite until the pedicle is long enough to be grasped by the bowel. In children bleeding from the anus is often the first thing noticed, and in the absence of injury may be regarded as almost conclusive. Sometimes the growth is extruded during defæcation, and is caught by the sphincter, giving rise to pain and spasm; and it may even slough off, and undergo spontaneous cure. In adults hæmorrhage is not so conspicuous, but there is usually a considerable discharge of mucus, like thin starch or white of egg, not only with the motions, but in the intervals. If the polypus comes down, the pain and irritation may be very severe, and it may drag the bowel down with it so as to cause prolapse, or, if it is situated higher up, intussusception.

A protruding polypus can be recognised at once by its appearance. If it is not visible at first, an injection may be given, and the part examined immediately after. When the finger is introduced it is advisable to pass it up to its full length at once, and search the mucous membrane as it is withdrawn; otherwise, a polypus with a slender pedicle may be pushed up in front of it and missed.

Treatment.—Polypi may be removed by torsion or ligature. The former answers very well in children, and, if the pedicle is really twisted off, is not followed by hæmorrhage; the latter is better if the pedicle is of any size, and for fibrous growths. An anæsthetic is advisable, and advantage should be taken of the opportunity to make sure that only one is present. If a ligature is used, the same precautions should be adopted as after operations on hæmorrhoids, for fear of ulceration.

PRURITUS

Many affections of the anus and lower part of the rectum are attended by a sense of itching, which may become so intolerable as to render the patient's life utterly wretched. It usually begins at night, as the body is getting warm in bed, and it may entirely prevent sleep; in the worst cases it lasts more or less all day, and the least friction brings it on. Scratching always makes it tenfold worse.

The skin around the anus in an old case is thickened, hardened, excoriated and often eczematous from the constant irritation. Sometimes nothing else can be found; the original cause may have disappeared, the complaint being kept up afterwards by this alone; more often there is some affection of the rectum—hæmorrhoids, prolapse, stricture, or merely a profuse mucous secretion that keeps the part continually moist. Venous congestion is the exciting cause in most cases; it is very common in connection with gout; many people only suffer from it when the liver is congested or the bowels constipated ; in others an attack is always brought on by certain articles of diet, especially alcohol and highly seasoned food ; in women it may be due to uterine causes, and in a few cases it seems to be associated with mental worry. Occasionally it is impossible to find a reason, and sometimes probably it is a pure neurosis, occurring whenever the patient is out of health ; as a rule, however, some definite exciting cause can be found if the case is watched.

The first thing is to remove every local affection that can act as a cause, and in recent cases this is usually sufficient. If, however, the complaint has lasted any time and the skin is altered in texture, it may be very obstinate. The bowels must be made to act regularly ; the diet must be restricted, especially in the direction of beer and spirits ; small doses of calomel or of podophyllin given from time to time, and if there is any suspicion of gout, lithia or potash, with sufficient fluid. A fair amount of exercise should be taken, and the part should be sponged well night and morning, and after each action of the bowels. A lotion of milk and acetate of lead may be used afterwards, or the glycerole of starch and borax. Cocaine always gives temporary relief, and is especially useful at night, securing some chance of sleep. If the skin is reddened and excoriated from constant scratching, mild astringent ointments are sometimes beneficial. In other cases, in which it is thick and hard, a strong solution of nitrate of silver or of acetic acid may be applied to the surface, taking care that none comes into contact with the anal margin. The patient must be kept in the recumbent position until the epidermis is restored again.

Dilatation of the sphincter succeeds sometimes after everything else has failed, especially if the spasm is severe. Allingham mentions that in one instance relief was obtained by the patient wearing a bone plug in the anus at night.

PROCTITIS

Catarrhal inflammation of the mucous membrane may arise from various causes : gonorrhœal infection, especially in women ; syphilis during the secondary stage ; abuse of purgatives ; gout ; errors in diet, &c. Except when it is due to the first of these, it is rarely severe ; there is a sense of heat and weight in the perinæum, with a constant desire to defæcate. The sphincter is in a state of painful spasm ; the anus is hot and tender ; the amount of mucus is increased ; and this escaping externally leads to excoriation and perhaps superficial ulceration. As a rule the symptoms subside as the cause is removed ; sometimes however they become chronic ; and occasionally, when severe painful catarrhal ulcers develop, require special treatment.

Ulceration of the rectum is much more serious, not only for itself, but from the way in which it leads to stricture and fistula. In some cases it is the result of injury, the introduction of foreign bodies, the use of enema-tubes or the passage of hard scybalous masses, especially as the circulation is often sluggish and the tissues badly nourished from the presence of varicose veins. In others it arises directly from thrombosis and inflammation of the veins ; or from dysentery involving the rectum as well as colon. When this occurs the ulcers it leaves are of a peculiarly irregular character : they spread in all directions, forming little islands which, as cicatrisation takes place, stand out as hard warty excrescences ; or they undermine the mucous membrane, so that it leaves rigid cords passing across the interior from one part to another; and the scars are of such extreme density that not improbably many of them have been mistaken for scirrhus.

In other cases ulceration is due to syphilis. In its earlier stages this attacks the anus chiefly; condylomata and superficial sores occur round the margin, leaving irregular folds of skin with painful fissures in between, not unlike those at the angles of the mouth and nose. In the later it breaks out on the mucous membrane, some distance from the anus, forming deep serpiginous sores, which may extend almost round the bowel.

Tubercle is still more common, beginning in the adenoid tissue between and beneath the follicular glands. Little nodules make their appearance first, not larger than millet-seeds, and only slightly raised above the surface; after a time these become caseous and break down, leaving shallow depressions, which grow larger and deeper, until at length they become circular sores with overhanging edges. In other cases, the caseous deposit seems to infiltrate the adenoid tissue in the mucous and submucous layers before the surface gives way, and deep irregular ulcers are formed, which almost at once become the orifices of tuberculous fistulæ.

Ulceration somewhat similar in character is not unfrequently associated with albuminuria; probably it originates as catarrhal inflammation; after a time the lymphatic follicles become affected, and break down; and then, as there is no longer any protection against septic infection, the deeper tissues become inflamed as well. In many cases it is difficult to distinguish this from the preceding; they both occur in patients whose health is broken down, and whose tissues are badly nourished; and they both lead to ulceration, and not unfrequently to fistulous channels of very much the same description.

In addition to these, lupoid ulceration may attack the skin around the anus and the mucous membrane of the rectum. It is essentially destructive in character and cicatrisation is unusual. The edges and base are not hard, as in malignant disease; and the former are undermined and overhanging. Sometimes it remains stationary for a time, and is apparently beginning to heal; then it all breaks down again. It is only met with in tuberculous subjects, and probably is itself tuberculous. The only treatment that has proved of any use is scraping and the actual cautery; sometimes the pain, at least, can be relieved in this way for a time.

Symptoms.—In acute inflammation of the rectum the patient complains of a sense of heat and weight in the perinæum, spreading over the back and thighs, and of violent straining and spasm of the sphincter. The skin is dry and feverish; the anus is very tender; the finger, if it is introduced, is tightly gripped; and the mucous membrane feels burning hot. In severe cases the constitutional symptoms are very marked; the pain radiates over the whole of the lower part of the body, and there is nearly always retention of urine.

The symptoms of ulceration depend upon its situation. When the anal margin is involved, they are so striking and so severe that this affection is described by itself as *fissure of the anus*; when, on the other hand, they are higher up, above the level of the external sphincter, they are at first very vague. Diarrhœa is the most prominent; as soon as the patient gets out of bed there is an immediate desire to go to the closet, and a small quantity of liquid fæces with some mucus, like white of egg, comes away. The same thing occurs perhaps once or twice in the morning; and then if the ulceration is not far advanced, the rest of the day is passed in comparative comfort; the rectum is empty and there is nothing to irritate it. In all but the slightest cases, however, there is a constant sense of fulness and tenesmus; normal motions are never passed; the amount of discharge increases; it loses its simple mucous character, and becomes dark, like coffee-grounds. Control over the sphincter is lost; the skin around the anus is constantly moist; it becomes covered with vegetations and excrescences, between which fissures form. Then the pain becomes more severe; after each motion it is intense, and in the intervals there is always a constant dull aching. Finally, the diarrhœa becomes almost continuous; health and strength fail; the appetite is lost; colicky spasms and pains over the lower part of the abdomen grow more frequent; abscesses and fistulæ form around the bowel; the emaciation becomes extreme; and the patient sinks from exhaustion, if he is not carried off by some intercurrent disorder.

Diagnosis.—In advanced cases the appearance of the anus at once suggests the presence of more serious mischief. The thickened and pigmented folds, with deep and painful ulcers in between, and the eczematous condition of the skin, can only be caused by long-continued irritation; but the diagnosis can only be made with the finger or the speculum. The former is nearly always sufficient; the latter can only be used with an anæsthetic, and with either the utmost gentleness is essential. Immediately inside the anus the mucous membrane is generally unaffected, though both in syphilis and advanced tubercular or lupoid disease it may be nearly as bad as the rest; higher up the normal soft character of the bowel is entirely lost. The surface is rough and irregular; hard nodules project here and there; in some places the walls are dense and thick, like stricture-tissue, and the passage is narrowed; in others there are soft smooth patches, surrounded with overhanging edges, which bleed at the least touch; and the finger when it is withdrawn is smeared with blood-stained mucus.

Sometimes it is possible from this alone to form an opinion both as to the extent and cause of the disease. Syphilitic ulceration is often accompanied by other signs; tubercle rarely leads to the formation of dense cicatrices, and fistulæ generally make their appearance very soon. Dysentery, on the other hand, may destroy all trace of normal mucous membrane, and often extends far beyond the reach of the finger. In the majority, however, a careful inquiry into the history, and into the other symptoms that are present, is essential; and even then it is sometimes difficult to exclude the idea of malignant disease.

Treatment.—Rest is the first consideration. The patient must lie down for at least the greater part of the day, with the foot of the bed raised to prevent venous congestion. The fæces must be kept as soft and as small as possible; everything that is stimulating or indigestible, or likely to leave a bulky residue, must be strictly avoided. Pure milk diet for a time is often advantageous. All straining must be prevented; the bowel must be washed out night and morning with warm water or an astringent lotion—nitrate of silver in the case of dysentery, lotio nigra for syphilis; and after this a simple unirritating ointment (calomel, gr. x, ad ℥j, nitrate of bismuth, iodoform, or nitrate of mercury), may be applied either as a suppository or with a suitable ointment-introducer. Starch and opium injections are the best means of controlling the diarrhœa.

In the meanwhile constitutional treatment must not be neglected.

Iodide of potash must be given in syphilitic cases. Cod-liver oil, if the patient can take it, often answers better than anything, as there is nearly always great loss of flesh and strength, and it tends to keep the motions soft; if iron is given care must be taken that the bowels are not confined. In a few cases where the ulcer is low down, and the spasmodic contraction of the sphincter is severe, perfect rest may be obtained by subcutaneous division of the muscle, or by stretching it; but this is seldom of any good in the more severe forms. In these, when all local treatment fails, colotomy is the only resource.

PERIPROCTITIS

Inflammation around the rectum may occur at the anus, in the ischiorectal fossa, or higher up in connection with the insertion of the levator ani and the rectovesical fascia.

1. *Inflammation around the margin of the anus* in many cases is symptomatic of some deeper disorder: there is a constant offensive discharge from the anus; the parts are continually moist; the epidermis is macerated off; and the deeper papillary layer of the skin exposed. Inflamed external hæmorrhoids, small cutaneous boils, suppuration in connection with the hair-follicles, and syphilitic eruptions are not uncommon. Very often it is due to injury, repeated straining, the passage of hardened fæces, the abuse of enemata, &c.; or it may occur after parturition. Of itself it may be trivial in character, but it becomes of great importance from the tendency it has to leave behind it painful fissures and superficial fistulæ.

2. *Ischiorectal abscess* is much more serious. It may be acute or chronic. In the former case the symptoms closely resemble those of proctitis. It may commence with a rigor: the pulse is quick, the tongue furred; there is the most intense throbbing in the perinæum; sitting down is almost impossible; the rectum feels as if it were loaded with fæces, but the least attempt at relief brings on the most violent pain and straining. On examination there is a hard brawny swelling by the side of the anus; the skin is red and œdematous, pitting on pressure; and if the finger is introduced into the bowel, the hardness can be felt through the wall for some distance above. Sometimes the inflammation is even more acute than this, and a form of gangrenous cellulitis which may prove fatal sets in.

In the chronic form, on the other hand, the swelling is painless, and often lasts for weeks. There is merely a soft fluctuating swelling, filling the whole of the ischiorectal fossa and extending up by the side of the bowel, covered in with a thin layer of discoloured skin. Not unfrequently the patient is almost unaware of its existence, and it may attain a very large size and burrow for a considerable distance before the skin gives way. When this happens the opening is always large and ragged, with thin overhanging edges, like those of a scrofulous sore, and a fistula is almost certain to be left.

The frequency with which these abscesses occur is accounted for partly by the ease with which septic absorption takes place through abrasions of the mucous surface, partly by the anatomy of the region. Owing to the rapid variations in size of the bowel, the tissues are badly supported; the circulation is feeble; there is a large amount of loose fat with dilated veins; and the vessels have even a greater tendency to become varicose than those of the lower extremities.

Phlegmonous inflammation is rare, except in those who are thoroughly broken down; most of the cases recorded have been in persons who were suffering from specific fevers. Acute abscess may usually be traced to exposure to cold; injury; perforation of the mucous membrane from the inside by a fish-bone or other foreign body; tearing of the mucous surface from straining or the passage of hardened fæces, or bruising of the subcutaneous tissue, leading to extravasation in the ischiorectal fossa or venous thrombosis. The chronic form is probably due in a very large number of cases to the breaking down of tubercular deposit in connection with the adenoid tissue of the rectum; or it may be a complication of stricture, beginning either from an ulcer on the mucous surface, or independently of this in the lowly organised inflammatory exudation surrounding the bowel.

In addition to this, suppuration may extend into the ischiorectal fossa from distant organs: urinary abscess is not uncommon; necrosis of the sacrum or coccyx occasionally gives rise to it; coccygeal dermoid cysts may cause it; and it has been known in caries of the lumbar vertebræ.

Ischiorectal abscesses should be opened at once and freely, or a fistula is almost certain to form. Even if there is merely a tense, hard, and painful swelling, it is better to run the risk of not finding pus. If the abscess is small and close to the rectum, so as to give rise to the suspicion that it is really intramural, the patient should be placed upon his side, with the knees drawn up, and the finger introduced into the bowel to fix the swelling and make it project towards the skin. Then a straight bistoury is introduced, and an incision, sufficiently free to give exit to the pus, made radially from the anus. Some of the outer fibres of the external sphincter are divided, and the opening will not close too soon. True ischiorectal abscesses, on the other hand, must be laid freely open by a longitudinal incision, parallel to the anus, midway between it and the ischium; and as soon as the pus has escaped, the finger must be introduced, the cavity explored, and the partitions inside broken down. Afterwards the opening must be kept patent to ensure the abscess healing from the bottom. Lint should be avoided, as the discharge is liable to collect behind it, and its removal is very painful. Gutta-percha tissue, folded irregularly so as to fit inside the orifice without blocking it, is the most convenient. The cavity, if the dressing does not come away easily, can be syringed out behind it, and it does not absorb the discharge. The patient should be kept in bed, or at least lying down, until the abscess has healed. If it is an acute one, this will not be many days; if it is chronic, the greatest care is necessary to prevent it degenerating into a fistula. The bowels should be well opened once, and then kept confined for several days, the diet being very light, so that there may not be an accumulation of fæces. When they are opened an effectual purge should be given to avoid straining.

3. *Inflammation on the visceral surface of the levator ani.*—This is nearly always caused by extension from some of the neighbouring viscera, and if it involves the rectum is nearly always associated with stricture. Occasionally it originates from the bowel, much more frequently from the uterus, following parturition or metritis, and probably it is for this reason that stricture of the rectum is so much more common in women than in men.

The inflammation may be acute, attended with high fever, and soon ending in suppuration; or chronic, spreading from one part to another until they are firmly bound down to each other and to the pelvis by bands of cicatricial tissue which may be almost of cartilaginous hardness. When it starts from the region of the uterus, the anterior surface of the rectum is first involved. The inflammatory exudation spreads into the substance of the muscles until the fibres become atrophied and the walls hard and unyielding; the mucous membrane becomes rigid and unable to unfold itself; the constant irritation caused by the passage of the fæces gradually leads to hyperæmia and thickening of the submucous tissue; and at length a definite stricture is formed, which may be either tubular in shape, extending for some distance along the bowel, especially on the anterior surface, or sharp, well-defined, and annular, about an inch and a-half or two inches above the anus.

If suppuration occurs the abscesses may break into the bladder or vagina, or they may extend out through the sacrosciatic foramina, or even burst into the general peritoneal cavity.

FISSURE OF THE ANUS

A distinctive name has been given to a small ulcer which occurs on the margin of the anus or on the mucous membrane just inside, because of the extraordinary severity of the symptoms to which it gives rise.

It usually lies upon the posterior wall, very often hidden by a small external pile; and so long as the anus is contracted, it has the appearance of a fissure lying between two rather œdematous muco-cutaneous folds. If, however, these are separated and the anus distended, it is seen to be really a circular or oval ulcer, lying sometimes on the white line at the junction of the skin and mucous membrane, sometimes wholly on the latter; in this case the symptoms are generally less severe. In some instances it is quite superficial; in others it extends completely through the mucous and submucous tissues and exposes the fibres of the sphincter beneath. As time passes the edges become thick and œdematous, and not unfrequently the mucous membrane is undermined, so that a short sinus runs upwards in the submucous tissue. Occasionally a fold grows out into a polypoid form, and lies in the fissure when the anus is closed; and if the disease lasts any time the sphincter and the levator ani always become hypertrophied, from their persistent contraction, so that the orifice is tightly drawn up when the least attempt is made to expose the ulcer.

An ulcer of this kind may be formed by any slight tear or abrasion; very often patients assign it to the passage of some especially hard motion; it is not uncommon after parturition; it may follow diarrhœa, and not unfrequently some syphilitic abrasion forms the starting-point; or it may be due to an inflamed external pile, an irritating discharge, or chronic congestion kept up by uterine displacement. In some people the orifice of the anus seems almost as prone to crack as the mucous membrane of the lips, but, fortunately, most of these little sores get well of themselves, or with very simple treatment; it is only a few of the cracks and fissures that give rise to the characteristic symptoms of fissure of the anus.

Symptoms.—Of these the chief is pain—pain of a most excruciating character, coming on as the bowels are acting and lasting perhaps for hours without abating. It is usually described as the pain of a red-hot iron, or of violent tearing; the patient is in a state of collapse, unable to move; the pulse is scarcely perceptible; and the forehead covered with perspiration; and this, in the worst cases, may continue for almost the whole day. In others it is less severe: when, for example, the ulcer lies above the white line it often does not come on at once, and may only last for a short time; but even so the patient may be entirely prevented from doing any active work. Very often the symptoms are aggravated by constipation; the patient dreads each action of the bowels, and postpones it as long as possible, so that the fæces become hard and dense and the suffering tenfold more severe. Retention of urine is a common consequence in men, and menstrual disorders in women. Dyspepsia, loss of health and strength, extreme anæmia, violent pains down the back and loins, and other effects soon make their appearance, until at length the sufferer and his friends are firmly convinced that symptoms of such intensity can only arise from malignant disease.

The **diagnosis** rarely presents any difficulty: neuralgia of the rectum is the only trouble likely to be mistaken for it; no other affection causes such peculiar and severe pain. Sometimes a stain of blood or mucus is noticed upon the motions, or there is a slight mark upon the skin. The anus, when it is inspected, is tightly drawn up and contracted, the glutæi closely approximated, and the sphincter feels hard and firm; sometimes there is a small external hæmorrhoid near the margin, or the edge of the ulcer may be seen. Examination with the finger is so painful that, where the symptoms are well marked, it is always advisable to give an anæsthetic. The orifice then can be dilated, and as the mucous membrane is everted with the pressure of the fingers, the whole of the ulcer becomes visible, first as a fissure, and then as a small round granulating surface, the base of which is sometimes covered with a thin slough.

The extreme severity of the symptoms is accounted for by the exposure of some nerve-filament upon the floor of the ulcer. The degree of pain varies very much in different cases; it is always less when the mucous membrane only is affected; and not unfrequently the excessive sensitiveness of the surface is limited to one or two small points, evidently the spots where the nerve-fibres are lying bare.

Treatment.—In the early stages the ulcer can sometimes be cured by keeping the motions soft, and applying a mild astringent ointment, nitrate of mercury, calomel, or sulphate of zinc, night and morning, and after every action of the bowels; but, as a rule, something further is required. The object is to give the ulcer perfect rest; if this can be done, and if there is no polypoid growth hanging over it, preventing its closing, it will generally heal in the course of a few days. The simplest plan is to apply caustic to the surface—nitrate of silver or the acid nitrate of mercury. The patient must be placed under an anæsthetic; the floor of the ulcer freely exposed, and then well cauterised, so as to cover it with a protecting layer. Afterwards the bowels must be prevented from acting for a day or two, and the patient kept in the recumbent position until the sore has healed.

If, however, the sphincter is hypertrophied, or if there is a polypoid growth overhanging the ulcer, this is not enough; and in most cases, even when neither of these conditions is present, it is advisable to adopt a more thorough proceeding from the first, dividing the superficial fibres of the muscle or stretching it so that it cannot contract. A combination of the two is the most useful, though either will succeed alone; the patient is placed under an anæsthetic, and the anus thoroughly dilated with the fingers; then, when the floor of the ulcer is exposed, an incision is made across it, about a quarter of an inch in depth, so as to divide the superficial fibres of the sphincter. If there is a small sinus under the mucous membrane it should be slit up at the same time; overhanging edges of mucous membrane should be excised, and any small polypoid outgrowth or hæmorrhoid removed as well. Complete division of the external sphincter is an unnecessarily severe proceeding; a very slight cut is usually sufficient, especially in those cases in which there is one exceedingly painful spot; if the nerve upon which this depends is divided, the pain ceases, the spasmodic contraction of the sphincter begins to relax; the ulcer is placed at perfect rest, and begins to heal at once. It is difficult, however, to make sure of doing this; and if the sphincter is very tense, stretching or superficial division is usually advisable. Sometimes the ulcers are multiple, but only one incision is required.

While the patient is under the anæsthetic the opportunity should be taken for thoroughly examining the rectum higher up. If there is any complication present, or if in women there is any displacement of the uterus, and this remains unrectified, it is highly probable either that the ulcer will not heal, or that, if it does, it will form again as soon as the patient begins to get about.

Fistula in Ano

By fistula, in the general sense of the term, is meant a sinus in the neighbourhood of the anus, left by an abscess which has healed up to a certain point, and then either remained stationary, or even grown worse. It may be complete with one opening in the bowel and the other on the skin; or incomplete, the internal or external opening only being present. The former of these is known as a blind internal fistula, the latter as a blind external one.

In point of importance, fistulæ may be divided into anal or rectal. The former merely occur near the margin of the anus, and are either entirely subcutaneous, or are merely covered in by some of the fibres of the external sphincter; the latter are larger and deeper, running from the ischiorectal fossa, between the sphincters, or even above the internal one; and are often complicated by sinuses under the skin or in the submucous tissue.

The causes of fistulæ are essentially those of the abscesses which give rise to them: injury to the mucous membrane from fish-bones or other foreign bodies; tubercular deposits; stricture; extravasation in the loose fatty tissue of the ischiorectal fossa; inflamed hæmorrhoids; cutaneous boils, &c. The reason of their persistence is to be found in the mobility of the part, the spasmodic contraction of the sphincter and the levator ani, and, if there is an internal opening, the constant entrance of irritating substances from the bowel. Blind internal fistulæ are the most rare; complete ones by far the most common, although it is sometimes a little difficult to find the internal opening. Probably most are incomplete at first, but the second opening is soon formed; the abscess, as it enlarges, works its way simultaneously towards the bowel and the skin, and unless it is opened exceedingly early the mucous membrane is separated from the subjacent tissue to such a degree that it gives way by ulceration even after the pressure of the pus is relieved.

A fistula may be either a simple straight passage from the skin to the bowel, or it may be complicated by sinuses running from it in every direction. The most common of these is in the submucous tissue; the internal orifice is nearly always on a level with the internal sphincter, seldom more than an inch or an inch and a half from the anus; but the sinuses may run up from this under the mucous membrane for several inches. More rarely, instead of taking this direction, it passes round the bowel, causing what is known as horse-shoe fistulæ, and opening sometimes on one side, sometimes on both. In other cases, especially where there is a stricture of the rectum, these off-shoots extend under the skin of the buttock, and even open several inches away.

The walls of a recent fistula are covered over with granulations, and secrete a thin purulent fluid; after repeated attacks of inflammation, they become thick and dense, and the lining smooth and glistening, like the surface of a chronic ulcer on the leg. The external orifice may be a mere pinhole, or lie in the centre of a little button-like mass of granulations; or, in tubercular patients and after the rupture of a chronic abscess, there may be a large irregular opening with undermined edges, like a scrofulous ulcer on the neck. The internal orifice presents very much the same character; sometimes it feels like a distinct little papilla resting on a base that is firmer than the surrounding parts; sometimes, on the other hand, especially in the case of blind internal fistulæ, it is a large irregular ulcer.

Symptoms.—So long as there is free exit for the discharge, fistulæ merely give rise to inconvenience and discomfort. The skin around the anus is constantly moist, the surface becomes tender and eczematous, and little cutaneous boils are apt to form. In the worst cases there may be an escape of fæces and flatus through the orifice, but there is never the agonising pain of fissure. Every now and then the orifice becomes blocked; the discharge collects; the skin becomes hot, and red, and tender; the action of the bowels is attended with pain, and a small abscess forms. As soon as this breaks, or is opened, the symptoms subside again, but each time it means either an increase in the density of the tissues around or the formation of an outlying sinus.

Diagnosis.—There is rarely any difficulty in this: the patient is usually aware already of the cause of his suffering; and the presence of a small orifice by the side of the anus, from which a drop or two of thin semi-purulent fluid can be squeezed, is conclusive; but this is not sufficient. It is necessary to ascertain the kind of fistula: whether it has an internal opening, and where it is; whether there are many sinuses in connection with it, and where they run; and, particularly, whether there is any cause for its persistence other than the action of the sphincter and the mobility of the part. There may be, for example, a stricture of the rectum high up, and a complete fistula with its internal orifice in the usual situation near the anus; or, what is even more perplexing, there may be a complete fistula and necrosis of the sacrum or coccyx at the same time; the diseased bone has caused the formation of an ischiorectal abscess, and this has led to the development of the fistula. Of course, in either of these cases, an operation upon the fistula only is worse than useless.

The patient should lie upon a couch, on the affected side, with the knees drawn up. In most cases the orifice of the sinus is visible at once, but sometimes it is very small, concealed behind folds, or closed for the time being. If it cannot be seen, the induration can nearly always be felt, even when the fistula is a blind internal one, and very often a little pressure causes a drop of pus to exude. Sometimes the whole track of the sinus can be made out with the finger.

When there is an opening a probe may be gently passed into it before anything further is done, in the hope that it may succeed in reaching the internal orifice without exciting the action of the sphincter. Usually the sinus runs almost under the skin towards the bowel. If this does not succeed the finger must be introduced and the mucous surface carefully explored just inside. Generally there is no difficulty in feeling the opening; if, however, it cannot be found, either a speculum may be used or some milk or other coloured fluid injected into the orifice; nearly always some of it finds its way into the bowel. It is a common mistake to pass the finger in too far at first and overlook the opening.

Blind internal fistulæ differ from the others. They usually communicate with the bowel by an aperture of some size; and, from the fact that fæcal matter is constantly entering and setting up inflammation, they are very often attended with a good deal of pain. There is no discharge externally; but the patient is usually aware of a swelling by the anus emptying itself every now and then into the bowel with temporary relief. Digital examination nearly always reveals a hard and painful mass in the ischiorectal fossa, and an irregular ulcer often of considerable size in the bowel. Occasionally the sac can be emptied by pressure; but to make the diagnosis certain, a probe bent like a hook must be passed down into the sinus through the anus. Fistulæ of this kind are usually caused by a foreign body perforating the mucous surface of the bowel, or by the softening of some tubercular deposit in the wall.

Treatment.—As a rule, fistulæ can only be cured by operation. In exceptional cases, in which there is no internal opening and in which the patient will submit to prolonged treatment, the sphincter may be stretched, the sinus stimulated with strong carbolic acid or tincture of iodine, and the external orifice kept widely open in the hope that it will close; but it nearly always ends in failure, after a long waste of time. The only method that deserves reliance is division of all the structures between the fistula and the anus, so as to lay it open from one end to the other and give it complete rest.

An aperient is given the night before and an enema the morning of the operation. The patient is placed under an anæsthetic, and laid on the affected side, close to the edge of the table, with the knees well drawn up, and held by an assistant, who also raises the upper glutæal fold. The sphincter is gently dilated and a director passed from the external orifice along the sinus into the bowel. Care must be taken to bring it out at the internal opening and not make a fresh one, except of course in the case of a blind external fistula. Then the point of the director is brought out through the anus, so that the structures to be divided are stretched over it like a bridge, and a clean incision made through them with a sharp-pointed bistoury (fig. 392).

If this cannot be done, the finger is introduced into the bowel, a blunt-pointed bistoury passed along the director until its end can be felt coming through the orifice, and then, after withdrawing the director, the finger and the bistoury are brought out together so as to divide with one sweep all the structures that lie between them (fig. 393). To avoid the risk of wounding the finger, some surgeons use a soft piece of fire-wood, into which the point of the bistoury is thrust.

After this, exploration must be made for outlying sinuses. A submucous one may be laid open with a pair of blunt-pointed scissors; or if from its position there is any risk of serious hæmorrhage, an elastic ligature may be passed through it by means of a suitable probe and tied as tightly as possible. Those under the skin are treated in the same way; or if they are of great length a drainage-tube may be passed along them and brought out through an incision at the other end. If one is overlooked, an abscess is almost sure to form before the wound is healed, and render a second operation necessary. In the case of old fistulæ lined with a smooth layer of false mucous membrane, either the walls must be scraped out thoroughly, or an incision made through them into the tissue outside, away from the anus, so as to ensure removal of all the indurated mass. Polypoid outgrowths and hæmorrhoids are dealt with at the same time; and loose and undermined flaps of skin are cut away, though discretion is necessary.

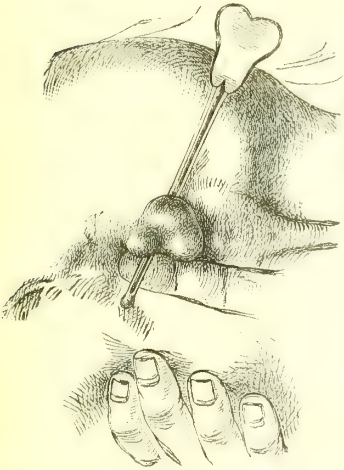


FIG 392.—Grooved probe passed through anal fistula before its division.

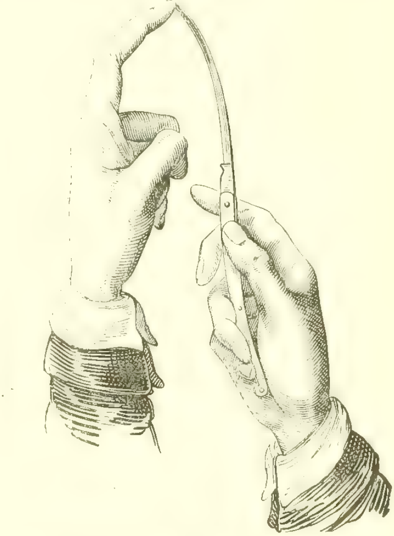


FIG. 393.—Method of dividing anal fistula.

Any bleeding point is tied or twisted at once, the wound packed with lint or cotton-wool, and a firm pad placed over the anus and secured in position with a T bandage. The following day all external dressings are removed and the deeper layer allowed to separate in a bath. The wound is cleansed night and morning and after each motion, pain being prevented by cocaine, and a single fold of lint laid between the edges. The application should be varied from time to time, according to the state of the granulations. The bowels should not act for four or five days after the operation, and the motions should be kept soft until the wound is perfectly sound. The recumbent position is essential until healing is completed, although it is not necessary for the patient to be kept actually in bed for more than a week or ten days.

I have succeeded in obtaining union by the first intention by thoroughly refreshing the base of the sinus after the sphincter had been divided, and bringing the surfaces together in accurate contact with deep wire sutures.

It is necessary, however, to remove them at the least sign of suppuration, or secondary sinuses may form. Probably buried catgut sutures would answer better; but this can only be tried when the fistula is recent and simple in character, and when the patient is young and healthy.

In cases in which there are deep sinuses, where there is much reason to fear hæmorrhage, or where the patient is exceedingly nervous, an elastic ligature may be used to divide the tissues gradually. It should be a solid cord, passed through from the bowel into the sinus, drawn as tightly as possible, and secured by means of a leaden clamp. Generally it cuts through in from six days to a fortnight, and without pain; but sometimes it is followed by serious inflammation, and if there are any secondary sinuses present (and it often happens that this cannot be determined until the fistula is laid open), it is almost sure to fail. The length of time that the wound takes in healing is approximately the same as after other methods of division.

Incontinence of fæces is always present for two or three weeks after the operation, and inability to control flatus for some time longer; but if the sphincter is divided at right angles, and in only one place, there is seldom any permanent loss of power. According to Allingham, it is fairly safe if ever so narrow a ring of the upper part of the band of the internal sphincter is left. An exception, however, must be made in the case of anterior fistulæ in women; the sphincter vaginæ and the sphincter ani decussate in the perinæum, and a free incision through the front part of the anus is not unlikely to be followed by incontinence. It is recommended in these cases to apply the actual cautery freely to the old cicatrices, and to the external and internal sphincters as well, in several places, so as to narrow the orifice of the anus by the subsequent contraction; and it is said that the muscular fibres, which are always very much degenerated, soon regain a considerable degree of their former power, probably because the dense scars formed in this way afford a firmer and better base for their action.

Phthisical patients are exceedingly liable to fistula, but, except in cases of rapid tuberculosis, or where the patient's health is distinctly failing, this is not of necessity a bar to operation. Very great care, however, is essential; the sphincters are often weak and should be interfered with as little as possible; the diet must be good; the patient must not be kept in bed too long, and a time should be chosen when the cough is not very troublesome; but even then the wounds are not unfrequently exceedingly slow in healing.

STRICTURE OF THE RECTUM

Stricture of the rectum may be simple or malignant. The former is either congenital or the result of injury and inflammation; the latter is always due to cylindrical epithelioma starting from the follicles of the mucous membrane and gradually extending into the submucous tissue.

In addition to this symptoms of obstruction may be caused by foreign bodies, by new growths occupying the interior of the bowel, or by tumours pressing upon it from the outside so as to close it more or less completely.

Congenital stricture occurs a very short distance inside the anus, where the rectal and anal portions of the intestine meet in the course of development. It usually takes the form of an annular constriction, and is really a minor degree of the defect which gives rise to one variety of imperforate anus.

Simple Stricture

This is much more common among women than among men, in the proportion of at least six to one. It may be annular or tubular, situated near the orifice, or at the junction of the anus and rectum, or higher up in the bowel. Generally it is single ; but it may be multiple, or it may spread over a considerable extent. Sometimes it feels like a cord tied around the bowel ; more often the surface is rough and irregular, deeply ulcerated in places, and covered with cicatrices in others ; and the walls, instead of being soft and yielding, are hard and rigid. The muscular fibres are wasted, and the connective tissue in and around the bowel so hard and dense, that the portion involved is converted into a rigid tube, down which the fæces are forced by the accumulation above. Generally the anterior part of the rectum is more affected than the rest, and not unfrequently the fibrous tissue around it for some considerable distance is as dense and hard as cartilage. Above, the bowel is distended and its muscular coat hypertrophied ; very often there is ulceration from the pressure of the fæces, and occasionally small hernial protrusions of the mucous membrane are formed, like those of the bladder in chronic cystitis. Below, the mucous membrane is always in a state of chronic congestion ; and catarrh, piles, prolapse, and fistula commonly occur. Outside, in the cellular tissue around, suppuration always breaks out sooner or later, sometimes starting from the mucous surface, sometimes independently ; and pelvic abscess, rectovesical or rectovaginal fistula, or even general peritonitis from rupture into the peritoneal cavity, may follow.

Causes.—Stricture close to the orifice may result from imperforate anus (the after-treatment not having been properly carried out) or from injury, ulceration around the margin, or operations upon external hæmorrhoids. Higher up in the rectum, it may commence from the outside—inflammation of the cellular tissue extending into the bowel from the uterus or other organs ; or from the interior, the mucous membrane becoming ulcerated and the submucous and other coats involved. The latter may be due to dysentery, a large portion of the sigmoid flexure and even of the colon being implicated ; or to tubercle or syphilis, the ulceration extending more or less round the bowel. Sometimes it is the immediate result of operation, too much of the mucous membrane having been removed with internal hæmorrhoids or prolapse ; more often it is due to the wound that is left failing to heal for a long time. Owing in part to venous congestion, in part to the irritation of the fæces and the constant contact with septic material, wounds of the bowel sometimes refuse to heal, and gradually extend by ulceration until, when at length cicatrisation does occur, the scars are rigid and hard and extend over a considerable area. Finally many of these cases are assigned to parturition, whether they are due to sloughing of the mucous membrane from injuries received at the time, or to inflammation of the cellular tissue around the bowel afterwards.

Spasmodic stricture of the bowel as such has no existence, but there is no doubt that many cases of ulceration and of organic stricture are complicated, and the symptoms made infinitely more severe, by spasmodic contraction of the involuntary muscular fibre in the wall, and perhaps of the levator ani as well. Whether this, if long continued, can at length lead to atrophy and fibroid degeneration is open to question.

Symptoms.—The symptoms of stricture of the rectum are partly those of obstruction, partly those of irritation and inflammation. Generally the latter are present first, but sometimes, when the stricture is higher up in the bowel than usual, obstruction occurs almost without warning. Diarrhœa of a morning, on first getting out of bed, and again after food; a constant discharge from the anus, keeping the skin moist and sore, and leading to the formation of tags and fissures; a sense of fulness about the part, with persistent desire to strain; and general uneasiness about the loins and down the thighs, are nearly always present. After a while there is difficulty of defæcation; attacks of constipation alternate with diarrhœa; normal motions are never passed; the fæces are in small hard pellets, mixed with mucus, like white of egg at first, later with coffee-ground débris. The pain becomes more severe, radiating from the perinæum all over the branches of the sacral plexus; the griping never ceases; the abdomen becomes distended with flatus; there is loss of power over the sphincter, so that wind and liquid fæces are constantly escaping; sympathetic troubles about the bladder and uterus set in; and the patient rapidly becomes worn out by the constant suffering.

If the disease is allowed to continue, the ulceration of the bowel becomes deeper and deeper; suppuration occurs in the tissues around, leaving fistulæ, which may open on the exterior or communicate with some of the neighbouring viscera; the suffering becomes intense; and death ensues at length from exhaustion, hectic, and profuse suppuration, or from peritonitis or intestinal obstruction.

Diagnosis.—The diagnosis of fibrous stricture of the rectum must be made by digital examination; the finger meets either with an annular constriction, or a hard tubular canal, the walls of which are rigid and unyielding. Only in a very few cases is it too high up. By placing the patient under an anæsthetic, slightly dilating the anus, and pushing the perinæum well up, the whole of the region in which fibrous stricture occurs can generally be explored. If nothing is felt, and the symptoms point definitely to obstruction, an attempt may be made to carry the examination farther by the long enema-tube, or by passing the hand into the bowel with the precautions already described.

Occasionally olive-headed bougies, similar to those used for examining the urethra, only on a larger scale, are of use for determining the length of a stricture.

Treatment. 1. *General.*—The diet must be nutritious, but such as to leave a very small residue; the motions kept soft; the bowels not allowed to act too often, and every assistance given them in the shape of enemata of glycerine or oil. Inflammation and ulceration of the mucous membrane are always present in bad cases of stricture as a consequence, if they are not the cause, and no pains should be spared to relieve them, and procure cicatrisation, by rest and mild astringent ointments.

Iodide of potash should be given if there is any evidence of syphilis, with enemata of lotio nigra; but it is only of use when there are specific ulcers; it has no effect upon the scars. Cod-liver oil is of great benefit even in cases that are not tubercular; pure milk diet may be tried with advantage for a time; and, in short, every attempt must be made to restore health and strength, while soothing the affected part as much as possible.

2. *Local.—Gradual dilatation* is the most successful; forcible stretching, unless the stricture is actually at the orifice, is dangerous. Where the opening is small and the tissues dense, a laminaria tent may be used; but in most cases gum-elastic bougies of different sizes, well softened and well greased, are preferable. A small injection of oil is given first, the patient lying on his side, and the bougie very gently guided into the narrowed part, remembering that, particularly in old-standing cases, the walls are very soft in places and easily torn. As a rule, the bougie should not fit the stricture closely, but if, after one or two trials, there is no pain or sign of irritation, tapering ones may be used with caution. In some patients the bougie must be withdrawn after a few minutes; others will tolerate them for several hours, so that no definite time for their withdrawal can be mentioned. A suppository of acetate of lead and opium, or a small injection of starch and laudanum, should be introduced as soon as the bougie is removed. It is sufficient in most cases if this is done every second or third day, gradually increasing the size. Where it is possible, the treatment should be kept up until a bougie an inch and a quarter or an inch and a half in diameter will pass with ease; and even then it is essential to make use of them occasionally afterwards in order to prevent a relapse.

Not unfrequently, after the treatment has been carried out for a short time, the rectum becomes irritable, the skin round the anus red and tender; the amount of discharge increases; and there is a certain degree of feverishness. In this case, the bougies must be left off at once, the patient confined to bed, and local sedatives applied until the inflammation has subsided again. If the treatment is persisted in, ulceration, and perhaps abscess and fistula, will follow.

Internal division of rectal stricture has little to recommend it; sometimes, when the constriction is near the anus and the mucous membrane only is involved, it may be practised; but unless great care is taken, it is not unlikely to be followed by ulceration, which may be very persistent. In the congenital annular form, where the surface is healthy, and there is no induration beneath, there is not the same objection. The bowels are thoroughly opened, the anus stretched under an anæsthetic, and the sharp margin of the projecting ring divided at three or four points, care being taken not to penetrate too deeply. The patient is kept lying down, and the bowels confined for three or four days; then a purgative is given, and, after the motion, the mucous membrane is thoroughly washed out with a weak antiseptic. Bougies should not be passed for two or three days, and the finger should be carefully introduced first to make certain that the wounds are healed.

Electrolysis has been tried for stricture of the rectum, as for stricture of the urethra, the negative electrode being applied to the face or the interior of the narrowed part; but, except that it is, perhaps, more rapid in its action, it is doubtful if it possesses any advantage over gradual dilatation, and it is certainly more likely to be followed by irritation and ulceration.

Linear proctotomy.—Unless great care is taken, and bougies are passed at frequent intervals, relapses are almost sure to occur, sooner or later, except, perhaps, in the congenital form. Each time the stricture becomes harder and denser, and at length more or less of the bowel is converted into a rigid, unyielding, cartiilagnous tube, with, perhaps, abscesses and fistulæ around it. If this is within a short distance of the anus, an attempt may be made to relieve it by what is known as linear proctotomy. The rectum is thoroughly washed out, the patient placed in the lithotomy position, and the finger passed through the stricture, some of its fibres being divided to effect this if necessary; and then, with a long curved sharp-pointed bistoury, the whole of the stricture-tissue is divided as near the middle posterior line as possible, right down to the sacrum, and out at the anus. Sometimes there is free hæmorrhage, especially high up at the angle of the wound, and to avoid this it has been recommended to use the écraseur; but it can usually be checked without difficulty by pressure. The operation is followed by profuse suppuration; but the drainage is good; there is free escape for the pus; and the part is placed at perfect rest. All that is required is that the cavity should be well irrigated once or twice a day. As soon as the wound is granulating freely and the sloughs have separated, generally at the end of a week or ten days, a soft bougie may be passed, to prevent recontraction.

Colotomy.—Finally, where this has failed or is impracticable, when there is obstruction owing to stricture high up in the bowel, or when there are fistulæ, especially if they communicate with neighbouring viscera, colotomy is the only resource.

Malignant Stricture

Epithelioma of the anus is not a very common affection. It is always the squamous-celled variety, and usually commences as a small nodule or wart, which may at first be mistaken for an external pile. Before long, however, the surface breaks down and ulcerates, and a sore is left, which, if it lies on the junction of the skin and mucous membrane, may be as painful as fissure.

Epithelioma of the rectum, on the other hand, is of very frequent occurrence, and, like that which is met with elsewhere in the large intestine, may appear not only in old age but during young adult life. It may involve any portion of the bowel; but usually there is a clear ring of mucous membrane for an inch or so just inside the anus; and not unfrequently the surface is free as far as the junction of the sigmoid flexure with the rectum, so that the growth is out of reach of the finger.

Its appearance varies very much in different cases. At the very commencement there may be merely a hardened, slightly raised patch, seemingly covered by the mucous membrane; soon, however, this begins to spread, both in extent and depth. The surface becomes rough and uneven; sometimes it grows out in the form of a nodule, which projects into the bowel and attains a very considerable size before it breaks down; more often it begins to ulcerate almost at once, and the destruction may extend so deeply as to leave but little of the growth at the base. The margins of the sore are raised, thickened, and hard; generally they are very irregular in outline; the base is exceedingly uneven, not unfrequently covered with sloughs, and at times bleeds freely; and the tissues lying beneath it are as hard as cartilage, and so fixed as to be quite immovable. Very often the ulcer surrounds the intestine like a ring, and the contraction of the tissues outside is so great that, in spite of the destruction, the canal is almost, if not altogether, closed; in other cases it forms a deep excavated sore on one side or behind, extending far beyond the limits of the bowel; and in others, again, the whole of the interior of the tube for some inches is ragged and irregular on the surface, so that nothing can be felt but the breaking-down epithelial growth.

The starting-point of the growth is undoubtedly in connection with Lieberkuhn's follicles, and in every example some portion of the tumour can be found with the characteristic adenoid structure of cylindrical epithelioma; but in some cases the epithelial element is in excess, and large vascular masses of new-growth are formed, soft, like encephaloid, and sprouting into the interior of the bowel; in others the fibrous part is more developed, and the base of the ulcer, the muscular coat of the bowel, and the fatty tissues around are infiltrated with a dense cicatricial mass to such an extent that when cut across it has all the appearance of scirrhus. The sacral and coccygeal glands are not involved till late; secondary deposits, unless the case terminates early, are usually found in the liver.

Colloid degeneration of small portions of the growth is not uncommon, and little masses like boiled sago may be frequently found here and there in its substance; much more rarely the whole growth is involved. Other forms of malignant disease are very rare. One or two examples of sarcoma are recorded, and melanotic growths have been known to occur.

Symptoms.—The onset is peculiarly insidious, and, especially when the growth involves the upper part of the rectum, and assumes the annular type, complete obstruction may occur suddenly and without warning of any kind, the orifice being blocked either with a small mass of hardened fæces or by a fold of the mucous membrane. As a rule, however, all the symptoms of non-malignant ulceration and stricture are present in an aggravated form.

At first there is merely an uneasy consciousness of the existence of the part, with a certain amount of irritation about the anus; or there is a slight discharge of blood-stained mucus, and the patient imagines that he has piles; then it becomes distinctly painful, especially after exercise or when the bowels have acted. Sometimes this pain is of a dull aching continuous character; or more often it takes the form of violent neuralgia, shooting down all the branches of the sacral plexus, especially on the left side. Occasionally it is relieved by the passage of the fæces; much more often every action of the bowels makes it tenfold worse, and, in spite of the constant desire and sense of fulness in the rectum, the patient looks forward to it with dread. As the passage becomes narrowed, the straining and tenesmus grow more and more severe; the fæces come away in hardened lumps; attacks of constipation alternate with a kind of spurious diarrhœa; a blood-stained and very offensive discharge is continually oozing out; the skin becomes inflamed and sore; prolapse of the mucous membrane or hæmorrhoids occur; abscesses, with violent throbbing and high fever, form in the cellular tissue around, and leave behind them fistulæ, which may open on the exterior or communicate with the bladder or vagina; and at length the patient becomes utterly worn out by the suffering.

Death may be caused at any time by peritonitis, hæmorrhage, or obstruction; or, if no complication of this kind sets in, secondary deposits make their appearance in the liver, the legs begin to swell, there is complete inability to take any food, night sweats come on, and the patient sinks from exhaustion, worn out by the constant pain, and emaciated to the last degree. The duration is very variable, and, owing to the insidious character of the earlier symptoms, exceedingly hard to estimate. As a rule, it is very much more rapid in the young than in the old; some of the quickly growing fungating forms prove fatal within a few months; others, in which the hard and dense fibrous stricture-tissue predominates, last for five and even six years. Unless some accidental complication appears, three years may be taken as the average.

Diagnosis.—In advanced cases there is no difficulty: the severity of the pain, the peculiarly offensive character of the blood-stained discharge, and the appearance of the anus, surrounded with piles and inflamed folds of skin, are sufficient. If the finger is introduced, it comes into contact with a hard, uneven stricture, generally about two inches from the anus. The orifice is often very small, and any attempt to pass even the tip through, is attended with extreme pain; the surface is rugged and dense, but breaks down at once with pressure, bleeding freely; and above there is a large irregular cavity, the walls of which are ulcerated all over. It is only in very extreme cases of syphilitic or dysenteric ulceration, that anything similar is produced. In the earlier stages of the disease, which are rarely seen, careful examination is necessary, especially as this form of carcinoma is not at all uncommon in young adult life, and any growth in the bowel which is surrounded by induration, or which cannot be moved freely upon the subjacent tissue, should be regarded with very grave suspicion, and a thorough investigation under an anæsthetic, with the anus well dilated, insisted upon.

When the growth occurs in the higher part of the rectum, above the reach of the finger, the patient may complain of attacks of diarrhœa alternating with constipation, but as a rule nothing else is noticed, until the constriction is far advanced and obstruction imminent.

Treatment. 1. *Radical.*—In all cases in which it is possible to remove it thoroughly, the affected portion should be excised without delay. It is very difficult to say how long a patient affected with carcinoma of the rectum may live without operation, but there is no question that if the diagnosis is made before the disease is far advanced, and, the whole of it is removed, it may be years before there is any recurrence; and, in the meanwhile, at the risk of what is not at that time a serious operation (whatever it may be later), the patient is relieved from a source of unceasing pain. For this to succeed, however, certain conditions are essential. The patient must be in a good state of health; extreme old age is of course a bar, but even quite late in life, if the kidneys are sound and the patient is not plethoric, excision is successful, provided the local conditions are good. The growth must be within a reasonable distance of the anus; that is to say, the finger must be able easily to reach above its highest limit all round the bowel. In the female, the peritoneal fold is usually less than three inches from the anus; in the male it is an inch higher, and it may be raised still more by moderate distension of the bladder; so that, especially in the latter case, a very considerable portion of the bowel may be removed. If, however, the anterior surface is involved high up, an operation is rarely advisable, not so much from the fear of opening the peritoneum, as because the growth is almost sure to have extended to it. Further, the wall of the rectum must be freely movable on the outside tissues. The case is most favourable when the disease is limited to the posterior wall or the sides of the bowel. If it involves the anterior surface to any extent, or if it has formed a complete ring, there is almost sure to be extensive infiltration of one part or another.

In this respect again, the prospect is distinctly not so good in women as it is in men: the vagina becomes implicated much sooner than the prostate; and though, according to Cripps, the operation is practicable so long as the vaginal mucous membrane remains free, it becomes very much more serious. Finally, there must be no secondary deposit in the liver, and no glandular enlargement, either sacral, or, if the anus is involved, inguinal.

Excision of the rectum.—The patient is prepared, in the usual way, by enemata, placed under an anæsthetic, and secured with Clover's crutch. The incisions are: (1) a crescentic one on each side, surrounding the anus (through the skin, if the external sphincter must be removed; through the mucous membrane inside the bowel, if this is not affected), and (2) a median one running back from this to the tip, or a little to the left side of the coccyx. The former should open up the ischiorectal fossæ thoroughly on each side; the latter should divide the posterior wall of the bowel, from above the growth down its whole length. It is usually recommended to make the vertical one first, by transfixion with a sharp-pointed bistoury from within the bowel, as this enables at once a thorough examination of the growth to be made in every direction.

The levator ani must be cut through with scissors, the anterior wall dissected off the prostate or vagina, as the case may be (a catheter or the finger being used to give notice of any approach to these organs), and the sides of the bowel separated as high up as required. As soon as it is thoroughly detached, the lower end is carefully cut off with stout curved scissors, clamps being placed at once on any vessels that bleed. If the peritoneum is widely opened, it must be secured with sutures; under other circumstances the sides of the wound fall together.

The bowel should not be drawn down and sutured; the tension is too great, and it encourages the retention of the wound secretion. A large drainage-tube should be inserted, and the whole cavity lightly plugged with iodoform gauze. This may be allowed to come away of itself in forty-eight hours, by placing the patient in a warm boracic bath.

As a rule, granulation and cicatrisation are very rapid, and but little after-treatment is required; the upper end of the bowel is drawn down and the sides fall together. As soon as healing is well established, a bougie should be passed at frequent intervals as often as required; or, if this is not sufficient, the patient should wear a suitably shaped vulcanite plug.

The operation is a severe one even when the peritoneum is not opened; but if the removal is complete and early, there is no doubt the duration of life is prolonged. The degree of comfort depends upon the success with which contraction is avoided. In rare cases the patients regain control (this is one reason for leaving the external sphincter when possible); more frequently they are comfortable so long as there is no diarrhœa, but a bougie must be used regularly. Occasionally the cicatrisation is very obstinate. If a strip of mucous membrane can be left the contraction is less severe, but the risk of recurrence is greater.

Resection of the rectum.—In Germany operations on the rectum have been carried very much farther than in England. Kraske of Freiburg, for example, does not hesitate to remove the coccyx, divide the left sacrosciatic ligament, and, if necessary, chisel off part of the sacrum. In this way the side of the rectum is exposed, the diseased part can be freely excised, and the upper end of the bowel drawn down and secured to the lower.

Bardenheuer does not limit the operation to malignant growths, but includes cases of rectovaginal fistulæ with a very large defect or with considerable kinking of the bowel; and some cases of stricture (although the presence of inflammatory adhesions usually prevents this). The whole of the rectum and part of the intestine above (upwards of ten inches) have been removed.

The incision runs from the posterior margin of the anus to the middle of the sacrum: the soft parts are detached from the bone, the sacrosciatic ligaments divided, and the sacrum itself cut across at the level of the third vertebra. The wound is widened by tearing the tissues in the middle line with the index fingers, and everything on the inner aspect of the levator ani that surrounds the bowel is detached by degrees until the rectum (below the growth) is thoroughly isolated. A loop is then passed round it, the peritoneum separated off (opened if necessary), and the bowel drawn down and divided about an inch and a half above the growth. The mucous and muscular coats are then united by separate sets of sutures and the wound plugged with iodoform gauze.

2. *Palliative.*—Where excision of the disease is impracticable the only thing left is to render the patient's life as endurable as possible and treat the symptoms as they arise. The general treatment must be the same as in ulceration and stricture due to other causes: the motions must be kept soft and small; the diet must be nutritious and easily digested, and the pain relieved by sedative injections, but care should be taken to avoid establishing a morphia habit in the earlier days of the disease; in the later ones it cannot be helped. Diarrhœa must be checked at once by starch and opium; the less frequently the bowels act the better, so long as there is no obstruction. Constipation caused by early contraction of the stricture is more difficult to deal with; as a rule, when the disease is high up, it is an indication for colotomy; but if it is quite close to the anus, and an operation is not thought advisable, relief may be obtained by bougies; this, however, is only practicable in exceptional cases, and even then the pain is so severe, and the risk of perforating the bowel and setting up inflammation around it so great, that it can scarcely be recommended. Sometimes, when there is a great fungating mass in the interior of the bowel, it is possible to tear it away or scrape it out, the anus having been dilated first so that there may be free access to every part; and it is said that if the operation is rapidly performed, there is but little hæmorrhage; but every precaution should be taken beforehand. Finally, if obstruction sets in, if fistulæ form, whether they open on the exterior or into one of the neighbouring viscera, or if there is intense pain caused by the passage of the fæces over the ulcerated surface, colotomy should be performed, as already described, either in the inguinal or lumbar region. Unhappily, it can do little or nothing in the way of relieving the intense neuralgia which is caused by the disease involving the sacral plexus.

VILLOUS TUMOUR OF THE RECTUM

Villous growths, similar to, but rather coarser than the fimbriated papilloma of the bladder, are occasionally met with in the rectum. Allingham, who has had the widest experience of them, describes them as forming a soft, lobulated, spongy mass, either sessile, or with a pedicle formed from the subjacent mucous membrane. In most cases they grow from the posterior wall, rather high up, and by far the greater number occur in people over fifty years of age. In some they caused severe hæmorrhage, and the growth occasionally became prolapsed; but the most striking feature is the constant discharge of large quantities of thin watery mucus. The diagnosis, unless some portion of the growth is forced out through the anus, is exceedingly difficult, owing to the peculiar soft velvety feel of the mass, which prevents its being distinguished from the natural folds of the mucous membrane. The only treatment is free excision; and this is especially necessary, as in a large proportion of cases malignant disease followed.

Nævus of the rectum is occasionally met with, and may give rise to very profuse hæmorrhage.

CHAPTER XX

INJURIES AND DISEASES OF THE KIDNEYS

ABNORMALITIES

Form and Number

The kidneys are occasionally united together more or less closely. There may be only a fibrous band between them, or the upper or lower ends may be joined together, so as to form a horseshoe-shaped mass in front of the vessels; or they may be fused into an irregular disc, lying somewhere near the middle line and not unfrequently as low down as the sacrum (fig. 394). As a rule there is but little inconvenience from this; but cases are recorded in which thrombosis of the great veins and hydronephrosis have occurred; and in one instance the pain during the menstrual period was so great that an operation was undertaken for the removal of the offending mass without its being known that it was the only kidney.

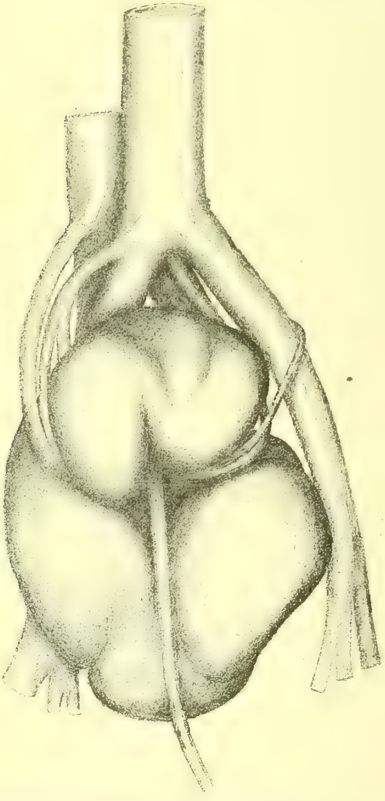


Fig. 394.—Single median kidney lying below the bifurcation of the aorta.

Size and Position

Variations in size are still more common. One kidney may be absent, and that too without the other showing any remarkable change. Both ureters may be present, coming from the single kidney, one crossing to the other side. More often, without being altogether deficient, one kidney is so small that it is doubtful whether it could, single-handed, be sufficient for the work of the body. This occurs so frequently as the consequence of disease that in all cases in which the removal of a kidney is contemplated it is essential to obtain definite information with regard to the efficiency of the other.

The vessels are often abnormal, both in position and origin. The most serious deviation is when an artery arises from the aorta higher up or lower down than ordinary, or from the common iliac. This is said to occur about once in seven. The ureter may be double, either at its commencement or for the whole of its course. Usually its direction is fairly straight; but sometimes it is seriously distorted or compressed by tumours; and occasionally, just where it springs from the pelvis, there is a valve of mucous membrane which may act as a very grave obstruction to the flow of urine.

The kidneys are not unfrequently found lower down in the abdomen or in front of the vessels, especially when there is any malformation. Sometimes they lie over the sacro-iliac synchondrosis, or even in the iliac fossa; and they may be the source of very serious trouble from enlargement at the menstrual period, or from acting as an obstruction during parturition. Pressure as a rule causes a peculiar sickening pain, and sometimes after handling blood appears in the urine.

Movable and Floating Kidneys

Owing to the loose character of the surrounding tissues, the kidneys are always slightly movable. If the lower end is exposed from the loin it may be seen to ascend and descend with respiration; and it can be pressed forwards with the finger or pushed back again by the hand upon the abdomen. When this movement is so free that it can be felt plainly from the outside, the kidney is said to be movable; it is floating if the range is greater still, so that it comes into contact with the front wall of the abdomen. In the latter case there may be a mesonephron, or fold of peritoneum investing the kidney like a portion of the small intestine, but it is very unusual.

Movable kidney is more common on the right side than the left, and in women than in men. The former fact is probably to be accounted for by the downward pressure of the liver and by the shortness of the left renal artery; the latter by various reasons, of which the use of stays, the effect of repeated pregnancies, causing great relaxation of the abdominal wall after great tension, and the comparatively sudden alterations in the amount of perirenal adipose tissue common under the same circumstances, are the most important. Conditions like hydronephrosis, calculus, or new growths which increase the weight of the organ, may assist, but of themselves are scarcely sufficient. In most cases the immediate cause is stated to be an accident of some kind, such as a fall in the sitting position.

Symptoms.—Sometimes a floating kidney merely causes inconvenience; sometimes, on the other hand, even when it is only slightly movable, it gives rise to intense suffering. A feeling of weight or of dragging, or of something being loose, is always present, and during the menstrual period and after exertion is very severe; riding is out of the question; and stooping and walking are very painful. Attacks resembling renal colic, attended with vomiting and great prostration, are of frequent occurrence: occasionally there is jaundice, or œdema from pressure upon the veins; sometimes the ureter becomes partially blocked from twisting, causing temporary hydronephrosis; dyspepsia and loss of health and strength are almost always present, and in many cases the patients become hysterical or hypochondriacal, so that they have even been known to make away with themselves.

The shape of the kidney can sometimes be recognised through the abdominal wall; the patient should be placed in the recumbent position with the hips well flexed; and if there is much pain or tension, an anæsthetic may be given. If the organ is not much out of place, it can usually be grasped between the hands, one buried deep in the flank, outside the erector spinæ, the other working downwards on to it; in other cases, when it lies in the iliac fossa or on the crest, the outline can be felt at once. Very often a better idea may be obtained by placing the patient upon the hands and knees, that the weight of the organ may bring it forward. Percussion in the flanks is rarely of much service; and, unless the handling is very rough or the kidney diseased, there is no reason why the secretion of urine should show any change.

There is some reason to believe (though it cannot be considered proved) that movable kidneys, independently of the accidents that may befall them from twisting of the ureter, &c., are more liable to be affected by disease than others.

Diagnosis.—Floating kidney itself is rarely mistaken, but many other conditions have been taken for it. Distended gall-bladders; fæcal masses in the colon; omental cysts; tumours of the pancreas; carcinoma of the pylorus; ovarian cysts; floating spleen, and many others, having been diagnosed as such, and in some instances the mistake was not apparent until the abdomen had been opened. Even when the tumour is superficial, it is easy to be misled by a vague resemblance in shape; when it is deep and scarcely movable, there may be nothing but the peculiar character of the renal pain to serve as guide.

Treatment.—In the slighter cases the patient may be fitted with an elastic abdominal belt, reaching well down to the pubes and Poupart's ligament, with an air-pad over the displaced organ to hold it up and press it back into the loin. Violent exercise, especially riding, or anything attended with jolting, must, of course, be avoided. If attacked by renal colic the patient should be placed in bed, the bowels well opened, and dry cups and hot fomentations applied over the loins. If this does not give relief, and the condition of the patient is such that it is necessary to adopt a more active line, the kidney may be exposed in the loin and stitched *in situ* (*nephrorrhaphy*). The incision is almost the same as for lumbar colotomy; the structures are divided in the same way and the perirenal fat exposed. This should be freely divided, and (while an assistant from in front pushes the kidney back into its place) several catgut sutures passed through its capsule, so as to fasten it to the lumbar aponeurosis over as wide an area as possible. A drainage-tube should be introduced down to the surface of the kidney, with the view of exciting a certain degree of inflammation. Probably the ultimate benefit many of these cases derive is dependent more upon the adhesions that form around the kidney than upon the sutures, which must soon be absorbed.

A healthy kidney should never be removed merely because it is floating, but a large proportion of true floating kidneys are diseased in some way or other, and then the conditions are, of course, completely altered. The abdominal operation is always preferred in these cases, as it enables a better idea to be formed, not only of the diseased kidney, but of the state of the other one.

INJURIES OF THE KIDNEY

Contusions and Lacerations

Tearing or bruising of the kidney is usually the result of direct violence, such as a blow upon the lumbar region, or crushing, as in railway accidents; or it may be produced by a sudden fall in the sitting position. The extent varies from merely a superficial contusion to complete disorganisation; and the symptoms depend partly upon the hæmorrhage and the escape of urine, partly upon the injury inflicted on neighbouring structures.

Hæmorrhage.—The amount of blood lost is very variable; in injuries of the cortex only there is rarely very much, but if the rent traverses the hilum, or one of the larger arteries has given way, particularly if the peritoneum is torn so that there is a large space for it to collect in, the patient may bleed to death. Usually it pours down the ureter and collects in the bladder, either at once, or after an interval of a few hours. If the quantity is large, coagulation is not uncommon, and long worm-like clots may form in the ureter, giving rise to the symptoms of renal colic, or even causing obstruction and hydronephrosis. In other cases the bladder becomes filled; there is severe pain over the pubes and at the end of the penis, and if means are not taken to break up and remove the coagula, decomposition may occur and cause acute cystitis. The colour at first is bright; but, unless the hæmorrhage persists, in a day or two it becomes smoky, and then gradually clears up.

Hæmorrhage around the kidney may occur in severe injuries: a swelling forms rapidly over the loins, and, later, staining makes its appearance in the inguinal region, and even in the scrotum, as the blood-stained serum travels downwards along the course of the vessels.

Extravasation of urine is rare, unless the pelvis of the kidney or the ureter is torn. Sometimes it escapes into the peritoneal cavity; more frequently it collects in the loose cellular tissue around the kidney, and, setting up a certain amount of inflammation, gradually forms a thin-walled cyst, which grows larger and larger, until it can be felt from the loins to the abdomen. This has been called *spurious* or *traumatic hydronephrosis*, but the condition is entirely different. As a rule, after a few days or weeks, the extravasation becomes general, and either acute peritonitis sets in or the patient sinks from septic absorption, caused by the suppuration and sloughing around the kidney.

The other symptoms are not characteristic. Pain is always present, usually of a peculiar sickening character, especially when any pressure is made upon the part; and in many cases it radiates down the thigh or to the testicle. All over the lumbar region there is great tenderness. The muscles, both of the abdomen and in the loins, are rigidly contracted; the body is bent to the injured side and the hip is kept in the flexed position. Sometimes there is pain along the course of the lumbar plexus, and very often the testicle is retracted up to the ring; but, if the injury is confined to the kidney, shock is rarely very severe. When the patient is much collapsed, there is always reason to fear either that the peritoneum has given way or that the hæmorrhage has been extensive.

Injuries of the kidney may be followed by true hydronephrosis from occlusion of the ureter; by peritonitis from extravasation of urine or extension of the inflammation; or by suppurative nephritis and pyonephrosis, the suppuration occurring partly in, partly around the kidney. When this happens, if the patient survives, urinary fistulæ are sometimes left, discharging through an opening in the loin or in the inguinal region. In one or two instances total suppression of urine has followed, possibly from obstruction to the renal vessels, but almost certainly in one case at least from the reflex influence of the nervous system. The same thing has been known to occur after operations on the kidney.

The prognosis depends upon the extent of the injury and the nature of the complications that follow. The majority recover without consequences of any kind; but if there is extravasation of urine, or much loss of blood, either at once or later, from giving way of the clot or the formation of an aneurysm, the question becomes very serious. Recovery, either complete or with the formation of a fistula, may take place even after suppuration; general peritonitis is almost hopeless, as this rarely comes on unless the injury is very extensive.

Treatment.—In the slighter cases all that is necessary is to confine the patient to bed on low diet, and empty the colon thoroughly by enemata. If bleeding continues the side may be bandaged; or Leiter's coils arranged over the lumbar region; and half-drachm doses of liquid extract of ergot given every two or three hours, only allowing the patient small quantities of ice to suck. A small amount of clot in the bladder may be left to soften and come away of itself; but if there is much distension or pain, it should be withdrawn with one of Bigelow's evacuating tubes and a suction apparatus, for fear of decomposition and cystitis. If the hæmaturia persists and it is almost certain from the amount of blood that is lost, and the rapidity, that some large branch is torn, an incision should be made in the loin, and, if the bleeding cannot be checked by ligature or plugging, the kidney must be excised.

Extravasation of blood around the kidney may be treated in the same way. If the swelling is very large and threatens to suppurate, the bulk of it may be reduced by aspiration, and subsequently the abscess opened and drained. When it is due to urine the swelling rarely appears until some days have elapsed, and the diagnosis cannot be certain until some of the fluid is withdrawn. If this contains urea, and if it can be shown by the aid of the cystoscope that no urine enters the bladder from the corresponding ureter, nephrotomy should be performed at once, the most convenient time being chosen after the patient has rallied from the shock, before there is any septic absorption. In other cases aspiration may be tried, and then, if necessary, incision—the fistula, if it persists, being dealt with later.

WOUNDS OF THE KIDNEY

The kidney may be wounded either through the loin or the abdomen; in the latter case the peritoneal cavity is opened, and probably other organs injured as well. In one or two cases prolapse has occurred, the whole organ being squeezed out through a wound in the loins.

The symptoms are the same as in contusion of the kidney, with, in addition, those due to the wound. The prognosis depends upon the nature of the injury: incised wounds heal readily; gunshot injuries, on the other hand, are very likely to be followed by suppuration and sloughing; but extensive urinary infiltration is not common. The lumbar plexus may be torn; the colon opened; and even the peritoneal cavity traversed by a bullet without the result being fatal. Fistula, however, and serious bladder troubles, phosphatic calculus and cystitis, not unfrequently make their appearance afterwards.

Hæmorrhage should be checked as soon as possible, and any foreign bodies that can be found removed at once, but prolonged exploration with a probe in order to find a bullet is not advisable. The wound should be left open; and, as there is always a tendency for it to become valvular, a large tube should be introduced down to the bottom. Later on, if suppuration occurs, free incisions are necessary. In prolapse of the kidney, if it is much injured, a ligature should be placed around the pedicle and the organ removed; in other cases an attempt may be made to return it.

SURGICAL AFFECTIONS OF THE KIDNEYS

Suppression of Urine

The secretion of urine may be checked in various ways. A calculus may be impacted in the ureter; acute nephritis may set in; or some sudden shock may give the circulation such a check that the blood-pressure falls too low; and this may happen even when the kidney is healthy. If it is already diseased—if there is, for example, chronic interstitial nephritis, so that the secreting power is already impaired, and the fibrous tissue is hard and unable to accommodate itself to rapid changes in the blood-supply—a very trivial reason is sufficient, and a cause that in a healthy kidney is scarcely enough to bring on a transient flushing, may be followed by such congestion as to stop the secretion altogether.

Causes. 1. *Shock.*—Suppression of urine may come on suddenly, from one instant to another, from shock. The passage of a catheter may cause it, even when the kidneys are sound; if they are diseased, not only is this more likely to happen, but when it does it is infinitely more serious. In the one case it is transient (though instances to the contrary are not unknown); in the other it may be final. This is one of the chief reasons why operations on the urinary organs are a matter of such grave consideration when the kidneys are diseased. So long as no extra strain falls upon them they may be equal to their work; the least disturbance, reflex or direct, is enough to stop the secretion altogether.

The way in which the suppression is caused is not always the same. It is due, no doubt, to the influence of the nervous system; but in some instances the nerves of the kidneys only are involved, in others the effect is general. In the former case there is intense renal congestion; only a small amount of fluid is excreted; its specific gravity is high, and often it is mixed with blood. In the latter the pressure is so low that, as in injuries to the upper part of the spinal cord, or in the shock that is associated with injury to the peritoneum, the blood lies almost stagnant, and no urine at all is formed. In the vast majority the secretion recommences of itself; but the result may prove fatal, either from general shock or from persistence of suppression, especially when the cause is a continuous one, such, for example, as a catheter tied in the urethra. It happens in women as well as in men; it has been known in children; and it is especially common after injury to the urinary organs, excluding the penile urethra. Nephrotomy on one side has been known to cause suppression on the other, so that there was for some time reason to fear that there might be only one kidney; calculus impacted in the ureter nearly always gives rise to it; there is hardly an operation about the bladder which it has not sometimes followed; while it is notorious after passing a catheter through the fixed portion of the urethra, especially in cases of recent stricture; in old ones the mucous membrane and the nerve-endings in it seem to lose their sensitiveness altogether.

2. *Acute inflammation.*—Scarlet fever, cold, cantharides, extensive lesions of the cutaneous surface and other causes occasionally lead to such extreme congestion as to cause suppression. The kidney becomes immensely swollen; the capsule is so stretched that it flies apart if it is divided with a knife; the cortex is thickened and either deeply congested or paler than natural, according to the relative amount of vascular and epithelial change; and the urine (such as is secreted) is stained with blood, of high specific gravity, and loaded with albumin.

Gradual suppression is met with chiefly in suppurative pyelonephritis. This is the condition which has received the exceedingly misleading name of *surgical kidney*, and which so frequently proves the cause of death in cases of long-standing stricture or enlargement of the prostate. The kidney is already in a state of chronic inflammation, the interstitial connective tissue is hard and dense, the secreting structure proportionately degenerated, and the specific gravity of the urine constantly too low; suddenly some irritant (a catheter, or ammoniacal decomposition of the urine) causes acute inflammation of the bladder; the ureters, the pelvis, and the substance of the kidney speedily become involved by direct extension; suppurative pyelonephritis sets in; a number of minute abscesses make their appearance in the cortex; the circulation becomes more and more embarrassed, the secretion more and more difficult, and in a few days or weeks the patient sinks into a low typhoid state with partial suppression of urine.

3. *Obstruction of ureter.*—Sudden closure of one ureter is usually followed by intense congestion of the corresponding kidney, and partial suppression of urine in the other from shock. If the obstruction continues the latter usually recovers, but the former gradually becomes more and more dilated, until at length hydronephrosis follows.

If one kidney is destroyed in this way, the other, provided it is healthy, undergoes compensative hypertrophy to make up the deficiency; and the urine that collects behind the obstruction is pale, of low specific gravity, with a diminished amount of urea, and sometimes a small quantity of albumin. If, on the other hand, the second kidney is actually or practically non-existent, suppression is complete from the first, without any warning other than that given by the previous attacks of renal colic.

In one lady under my care total suppression had already lasted nine days (there was a history of a previous attack that had continued for six, and had at length yielded with the passage of much blood and gravel). On the tenth day I opened the kidney on the left side through the loin, and found the pelvis at an enormous depth, but no calculus could be detected, even with a probe. The patient, who was at the time suffering from the most intense muscular weakness, rallied and lived for a month. *Post mortem* it was found that the right kidney and the right ureter were completely absent; the left measured eight inches by four, and was somewhat displaced; there was a large calculus impacted low down at the junction of the pelvis with the ureter.

Symptoms.—Suppression of urine is in itself only a symptom, and the consequences that follow naturally depend upon the cause. *When it is the result of shock*, whether this is due to severe injury to another part of the body, or is the consequence of an operation upon the urinary organs, the secretion may return within a few hours, before any harm is done, or the shock may prove fatal.

In *nephritis* the symptoms are, to some extent, the result of the suppression. The acute form—that, for example, which occurs after scarlet fever—is seldom met with in surgery, and cases are rarely seen with the typical symptoms of rapid anasarca, coma, and convulsions. The chronic variety, however, that which follows irritation of the urinary organs in cases of stricture and enlargement of the prostate, is exceedingly common. The symptoms are slow in their onset and very insidious; there is no rigor, though the temperature may rise in the course of a day or two to 102° F. or 103° F.; the pulse is quick and feeble, the tongue hard, dry, and brown, and the strength fails rapidly. The patient lies prostrate, in a state of semi-unconsciousness; the mind is constantly wandering; there is total inability to take food; vomiting is not unfrequent; very often there is great restlessness, and, towards the end, sometimes coma; but convulsions are rarely present.

Obstructive suppression, on the other hand, or that which follows the removal of the only working kidney, is totally different. For the first three or four days there is nothing at all remarkable; then gastric disturbance, with, perhaps, vomiting, sets in; but the most striking symptom is the failure of the muscular strength. The mind is quite undisturbed, the temperature is not raised, and the pulse is scarcely quickened. Generally at the end of a week, but sometimes not for ten days, a change sets in, and then the end comes rapidly. The pupils become contracted, the muscles begin to twitch, the temperature falls below normal; the respiration becomes difficult and panting, owing to the weakness of the muscles; the patient is confined to bed; sometimes there is apathy or drowsiness, but never coma or convulsions, and intelligence is retained to the last. Death seems to be due to respiratory and cardiac failure: a week or ten days is not an unusual time; in a few instances life has been prolonged for even greater periods.

Hydronephrosis

By this is meant a gradual dilatation of the pelvis and calyces of the kidney, with absorption of the secreting part, until at length a sac is formed, large enough, perhaps, to contain a gallon of fluid, or, if it occurs before birth, to prove an obstacle to parturition.

It may be congenital or acquired, though the latter is the more common; and, according to the cause, it may affect one side or both. In all cases it appears to arise from an obstruction to the outflow of urine; the secretion continues, gradually stretching all the surrounding structures, until at length the renal substance is so thinned that it is no longer able to work; and then sometimes, but very rarely, the fluid may be absorbed again. The secretion, under these circumstances, differs from normal urine, in containing albumin and mucin with very little urea. Whatever the explanation may be, this always happens when there is any hindrance to the flow; it may be noticed even when the obstruction is only of a temporary character, as in renal colic; and, if the cause is removed before the kidney has undergone atrophy, the percentage of urea may rise again to the normal, and the albumin and mucin disappear.

In the slighter cases the shape of the kidney is, to a certain extent, retained; there is merely dilatation of the pelvis and calyces, with widening of the collecting tubules, and increase in the amount of interstitial connective tissue; in extreme ones, nothing is left but a thin-walled cyst, generally rather elongated, especially if the obstruction is low down, but so modified by pressure that it cannot be said to possess any form of its own. Probably the largest cysts arise from comparatively sudden obstruction in a healthy kidney; when it is gradual the wasting of the cortical part prevents much accumulation.

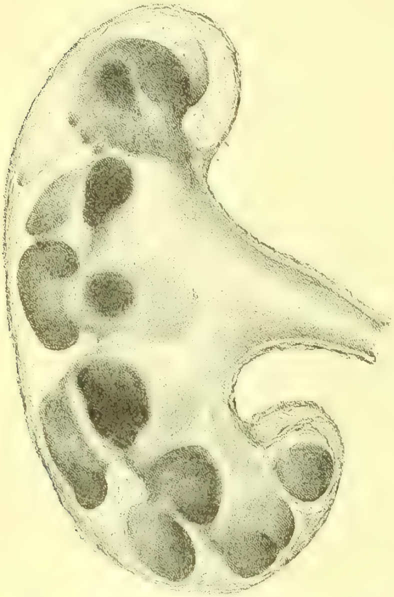


Fig. 395.—Hydronephrosis with complete atrophy of renal tissue, but not much enlargement.

Causes.—The obstruction is generally in the ureter, but in the bilateral forms it may be in the bladder or the urethra; and it may be the result of some foreign body in the interior, of some structural change in the wall itself, or of pressure from the outside.

1. Of these the impaction of a calculus is by far the most common. Usually it is caught either at the commencement, just where the pelvis grows narrow, or at the end, perhaps half projecting into the bladder; but it may occur at any point. Clots of blood and hydatid cysts are said to have produced the same result.

2. Structural changes may arise from various causes. Stricture of the ureter may occur from inflammation. Granulations may form on the mucous surface and become coated over with phosphates. Papillomata, similar to those found in the bladder, are occasionally met with. Cancer of the pelvis of the kidney may lead to the same result; or there may be a fold of mucous membrane just at the commencement of the ureter acting as a valve. In a few instances congenital atresia and absence of a ureter have been recorded. Imperforate urethra; stricture and other affections of the urinary passages; even phimosis, and great increase in the frequency of micturition, sometimes occasion a slight degree of it in both kidneys, with or without dilatation of the bladder.

3. Very slight external pressure is sufficient to cause it. Mere twisting or looping of the ureter is enough, or the pressure of a tumour, such as the retroflexed uterus. It has even been caused by an abnormal renal artery crossing the ureter, and by one ureter opening so close to the other as to impede the flow from it.

Symptoms.—Hydronephrosis is rarely discovered until the swelling has reached a considerable size. It begins first high up, under the last rib, and spreads downwards into the iliac fossa, and forwards to the middle line, carrying the colon inwards in front of it. If there is any doubt as to the position of the intestine, it can generally be made out by inflating it with air. Fluctuation is usually distinct: there is absolute dulness on percussion, and a sense of deep-seated resistance on palpation. Sometimes the distension is so great as to interfere with the action of the bowels and with respiration.

If the obstruction is sudden, there may be a great deal of pain with blood in the urine; in most cases there is little more than a sense of discomfort with constant dull aching. Occasionally the volume varies in size; the obstruction suddenly gives way; there is a profuse discharge of clear or slightly turbid fluid, and the tumour disappears. Intermittent hydronephrosis, the fluid being expelled as soon as the tumour reaches a certain size, and then collecting again, is not unknown. It may arise in some few cases from spasmodic muscular contraction; but more probably from bending or looping of the ureter, as in floating kidney, or from compression by a tumour.

Diagnosis.—From pyonephrosis it can only be distinguished by the constitutional signs. Hydatids of the liver, spleen, or kidneys are almost as difficult until they have been tapped; the fluid they contain is of higher specific gravity, 1,010 or 1,012, instead of 1,004, and the proportion of sodium chloride is much higher. Ovarian cysts, as a rule, are more mobile; they begin in the pelvis and spread upwards; and the relation they bear to the intestine, and especially to the colon, is not the same. Ascites in certain very rare cases is so limited by adhesions that it presents a close resemblance; and a few instances are recorded of perirenal cysts which scarcely admit of diagnosis during life.

Rupture of the ureter occasionally leads to a subperitoneal collection of urine, which has been called spurious hydronephrosis, but the condition is very different. Renal and perinephritic abscesses are quicker in their course and are attended with a much greater amount of pain.

Hydronephrosis, if left to itself, may prove fatal either from exhaustion, or pressure upon other organs, or from rupture into the peritoneal cavity. Occasionally it remains stationary for years, until perhaps the secreting power of the kidney is completely destroyed; sometimes then the fluid is absorbed again, and in a few instances spontaneous cure has resulted from the sudden yielding of the obstruction.

Treatment.—The slighter degrees, those which arise from gradual or partial obstruction, are rarely diagnosed. When it is so large as to form a distinct tumour, it is usually necessary to take some steps for its removal. In a few cases manipulation and gentle kneading over the ureter, assisted by opiates and warm baths, have proved successful. Occasionally the tumour can be raised by external pressure, or shifted by changing the position of the body, so as to release the ureter for a time and allow the fluid to escape; and in one or two instances ureterotomy has been performed with a good result; but, as a rule, the obstructing cause is either beyond this or the walls of the sac are so softened and thinned that the danger of rupture into the peritoneal cavity is too great.

Repeated puncture, aspiration, and injection with iodine, have been tried in cases in which the renal substance has disappeared and there is nothing but the cyst to deal with. In the majority, however, free incision through the lumbar region with drainage, affords a better prospect; especially as it is sometimes possible, by examining the upper end of the ureter in this way, to find and remove the cause. The great objection is that urinary fistula is liable to form, and that, if suppuration should occur as a consequence of defective drainage, the structures around the cyst-wall are so matted together as to render its removal subsequently a matter of great difficulty.

In many instances, however, the fistula gives rise to but little inconvenience; and if it does, and if it is proved that the other kidney is sufficiently active, the renal substance can as a rule be enucleated much more easily through the wound, and with much less danger to the patient, after the cyst has contracted to moderate dimensions, than while it is still so large as to displace and compress all the neighbouring organs.

If, however, the condition at the time of the operation is plainly irremediable, and the cyst-wall can be separated easily, nephrectomy may be performed at once.

TUMOURS OF THE KIDNEY

Diagnosis.—New growths in the kidney must be distinguished from cystic degeneration, hydronephrosis and pyonephrosis, from abscesses around the kidney in connection with the vertebræ, pleura, cæcum, colon, liver, or the pelvic, urinary and genital organs; from dermoid and hydatid cysts; from cysts of the ovary and pancreas; from enlargement of the spleen, and in children from enlargement of the mesenteric glands.

The history (family as well as personal) and the general symptoms (especially if there is any pyrexia, or evidence of any diathesis) are of very great importance; the urine must be carefully investigated, not only once, but for days together; the abdomen and the loins thoroughly examined; and finally, if there is still any doubt as to the nature of the swelling, it must be explored with an aspirating needle.

To examine the kidney, the patient should be under an anæsthetic, to relax the muscles; one hand should be placed in the hollow of the flank, between the last rib and the crest of the ilium, the other just below the cartilages of the ribs, on the front wall of the abdomen. In this way the lower third of the organ can be felt and fairly grasped, even when it is not enlarged, and the size, shape, mobility, and consistence can usually be made out. As it enlarges, it extends towards the middle line in front—(it never causes any prominence behind, although it may fill up the hollow of the loins)—but, except in the case of sarcomata or cystic disease, it rarely reaches the middle line, or extends so far down into the pelvis that the hand cannot be introduced beneath it. New growths of the kidney are usually so soft as to give the sensation of fluctuation.

The relation of the tumour to the colon is most important. It depends to some extent upon the side; on the right, as the kidney enlarges, the cæcum and the lower part of the colon are pushed back to the outer side of the tumour, while the upper part crosses obliquely in front. On the left side the colon lies well in front, and can be felt as a rounded cord rolling over and over under the finger; or, if it is filled with air, a line of resonance can be made out where the kidney is percussed. It very rarely happens that a coil of intestine intrudes itself between the liver or the spleen and the abdominal wall. Resonance in the flanks is never present when there is a renal tumour of any size.

Finally, in case of doubt, the kidney may be explored behind the peritoneum with an aspirating needle. It may be introduced just at the outer edge of the erector spinæ, on a level with the first lumbar vertebra, or, if the kidney is enlarged, midway between the last rib and the crest of the ilium; and the direction of the needle should be forwards and a little downwards—in fact, as nearly as possible towards the umbilicus. As a rule, if the trocar is about four inches long, there is no fear of injuring any important structure, and the sudden cessation of resistance, as soon as the shoulder of the instrument enters an open space, can be felt at once.

Cysts

Cystic disease of the kidneys, like hydronephrosis, may be either congenital or acquired, and may occur on one side or both. In many instances the whole organ consists of nothing but cysts, of all sizes, from a pea to an orange, so that, if both are affected, there is practically no secreting substance left. Not unfrequently, on the other hand, its existence is never suspected at all, and it is only discovered *post mortem*; the only symptom is the persistent low specific gravity of the urine, and even that is not invariable. Occasionally, in adult life, the cysts enlarge to such an extent that the tumour becomes the source of serious trouble, from pressure upon neighbouring organs.

The cysts usually contain an albuminous fluid with a small quantity of urea: occasionally uric acid is found as well, and not unfrequently traces of old hæmorrhages. The consistence, however, may be so thick as to resemble colloid. The walls are always thin, and lined with a single layer of flat epithelium. In most cases they originate from the urinary tubules, which have been blocked, either by inflammation and degeneration of the epithelial cells (caused possibly by the infarcts of uric acid that are found in the kidneys shortly after birth), or by the organisation of lymph thrown out around them. Sometimes they may be derived from the glomeruli.

As a rule, these cases do not admit of treatment. When there is an enormous enlargement on one side, an attempt may be made to obtain relief by aspiration, or by nephrotomy; and if it can be shown that the opposite kidney is, if not intact, at least capable of doing the whole work of the body, nephrectomy may be performed, but not otherwise.

Besides these, cysts, sometimes of considerable size, are of common occurrence in granular kidneys, but they seldom require treatment. Dermoid cysts are occasionally met with, and they have been diagnosed by the passage of hair and débris with the urine. Hydatids are not common; when they occur in the substance of the kidney they usually rupture into the pelvis, and the discharge of the daughter-cysts may give rise to repeated attacks of renal colic. They may be treated either by aspiration or by free incision and drainage; if left to themselves, they sometimes dry up and give no further trouble; but not unfrequently they suppurate, and then they must be treated by free incision, in the same way as other renal and perinephritic abscesses.

Solid Growths

New growths in connection with the kidney are nearly always malignant (carcinoma or sarcoma). Tubular adenoma, fibroma (originating from the capsule), papilloma (growing in the pelvis, and resembling the villous tumours of the bladder), angeioma, and lymphadenoma, have been described, but they are all very rare. Besides these, fatty tumours are said to occur, but it seems probable that they are really derived from portions of the suprarenal capsule detached from the main body in the course of development.

Carcinoma rarely occurs before adult life, and is most common after forty. It seems especially prone to attack floating kidneys, and is not unfrequently associated with calculus, though it is difficult to be certain of the relationship that exists between them. It is nearly always encephaloid, though a few cases are recorded in which the fibrous stroma was so dense as to deserve the name of scirrhus ; colloid may occur secondarily. In many cases they originate in the structures about the hilum, and only penetrate the pelvis after a certain length of time, pushing the renal structure before them ; and perhaps this may explain the frequent absence of diseased products in the urine.

Sarcomata may be congenital, and are much more common in the young than in the old. For the most part they are small-celled, and very vascular. In a few cases they have been found to contain large quantities of fibrillated bundles arranged in different planes, crossing one another in all directions, and composed for the most part of striped muscular fibres.

Symptoms.—The signs of malignant disease of the kidney are, as a rule, very obscure, until it has reached an advanced stage and formed a definite tumour. Hæmaturia may be present, and when it is, it is generally profuse, but it may remain absent almost through the whole course. Pain is rarely wanting; usually there is a dull aching in the loin ; and later, violent neuralgia shooting down the branches of the lumbar plexus ; and sometimes there is intense irritability of the bladder. Contraction of the psoas muscle, leading to lameness and a suspicion of hip-disease ; jaundice, especially when the right side is concerned ; œdema of the legs from obstruction to the circulation ; constipation from pressure upon the colon, and vomiting, probably reflex in character, are not uncommon. The urine may show no sign ; more frequently there is hæmaturia at one time or another ; albumin is only present when there is blood, and renal colic may occur under the same conditions.

The question of operation under such circumstances is very doubtful. It rarely happens that a diagnosis can be made until the kidney is definitely enlarged, and then complete removal is almost hopeless. Sarcoma in children is probably the worst, and it is very rare to meet with a case in which nephrectomy is justifiable ; in the case of adults, and with carcinoma, there is a little more hope ; it is known that patients have lived for a considerable period without recurrence ; but the operation cannot be recommended unless it is probable, from the duration of the case, that the disease is still limited to the kidney.

Renal Calculus

Renal calculus may occur at any period of life, but is most common at the two extremes : and it may be formed either of urate of ammonium, uric acid, oxalate, phosphate, or carbonate of lime, ammonio-magnesian phosphate, cystin, or xanthin. Of these, the first is most common in infants ; the next two during adult life ; while the rest, especially the last two, are very rare. Not unfrequently the calculi are laminated, layers of different substances, more or less pure, alternating with each other, according to the reaction and character of the urine at the time.

Some are developed in the calyces, others in the epithelium of the urinary tubules. The former are composed of triple phosphate, and are either formed around blood-clots, or, in cases of pyelitis, as concretions on the roughened and ulcerated surface of the mucous membrane when the urine becomes ammoniacal. The cause of the latter is more obscure. Some originate from the infarcts in the renal tubules of infants; and these, though they may be multiple, if once removed, never return; the condition which gives rise to them disappears as soon as the urinary secretion is well established. In the case of others, the fault appears to lie in the epithelial cells; their energy becomes impaired, whether from long-continued overwork, old age, or disease; they lose their power of discharging into the urinary tubules the materials withdrawn from the blood; and, as a result, these increase and accumulate until at length a nucleus is formed. It is probable that this only takes place when there is at the same time a morbid condition of the urinary passages leading to the production of a suitable colloid medium. There is evidence to show that when a material of this kind is present the urinary salts are precipitated, not as perfect crystals, but in a modified form, similar to the rounded masses that are found as nuclei; and it is certain that the mere increase in the amount of urinary salts is not a sufficient explanation. However this may be, these calculi differ in one very important respect from those that occur in infants: they are the result either of inheritance or of faulty modes of life, such as excess of nitrogenous food, or of strong wines; and as the causes usually continue in activity after the calculus is removed, recurrence is not uncommon.

Symptoms.—Renal calculi may be small, round, and freely movable; encysted, so that they are practically fixed; or large, branching masses, reproducing somewhat the shape of the pelvis and calyces after the secreting part has been partially destroyed (fig. 397). The general symptoms are the same in all, but they vary greatly in intensity. In every case the family and personal history should be thoroughly investigated; the tendency to the formation of calculi is undoubtedly inherited, and recurrence very common.

Pain is always present. Two chief varieties can be distinguished, though there is every intermediate gradation; one is dull, aching, and continuous, felt mainly in the loins, but radiating down the thigh, into the groin, and especially into the testicle. It is present in nearly all, and is especially severe after moving or jolting, as in riding, and after the pelvis has become inflamed. The other (*renal colic*) only occurs with small and movable calculi when they drop into the orifice of the ureter and throw its muscular fibres into a state of spasmodic contraction. It is usually brought on by some sudden movement; often it begins with a rigor, and it is of the most intense description, shooting down to the testicle, into the thigh, and, perhaps, over the whole of that side of the body. *Nausea* and *vomiting* generally occur at the same time; the patient rolls over and over with agony, lying curled up as much as possible to relax the muscles; the face is pale and shrunken; there is extreme collapse; the forehead is covered with perspiration; the skin is cold and clammy; and the pulse at the wrist can scarcely be felt. It is not continuous, but comes on in paroxysms, and may end quite suddenly; many patients never suffer from it at all; in others it returns again and again at intervals of a few weeks or months, each time causing fresh mischief in the kidney, until the calculus is either passed or becomes so large and so surrounded by inflammatory exudation, that it can no longer occupy the narrow part of the pelvis. The same symptoms may be caused by the passage of blood-clots, and even by hydatid cysts set free in the pelvis. In many cases the pain is referred to other parts of the body, especially to the genito-urinary tract, and along the course of the lumbar and upper sacral roots. *Neuralgia of the testis* is of frequent occurrence; sometimes it is so tender that it can scarcely be touched; *irritability of the bladder* is often present, and may, as in strumous pyelitis, be exceedingly severe; sometimes there are *paroxysms of pain*, shooting down the foot or leg, similar to the lightning pains of locomotor ataxy; or a constant burning sensation in the heel; or intense sciatica. In fact, wherever paroxysmal pain occurs in the lower extremities, especially if it is attended by nausea and retching, or with any alteration in the condition of the urine, the possibility of renal calculus must always be borne in mind.

Retraction of the testis is very significant. When the calculus is in the ureter, it is rarely absent, and the gland may be held tightly up against the abdominal ring. It is not so well marked or so constant while the stone occupies the pelvis.

The examination of the urine is most important. Blood is almost always present at one time or another, especially after exertion, and it is always evenly mixed with the urine. If the hæmorrhage is recent, the colour is bright red; if some time has passed, dark brown or smoky, or even almost black like porter. The amount is rarely large, and coagula are not often met with, except after the spasm of renal colic; then the whole organ becomes tender and congested, and it may pour out in considerable quantity. In other cases large quantities of gravel or brick-red crystals of uric acid may be found from time to time. Mucus is always present and sometimes epithelium, which may be recognised as coming from the pelvis; so long as the urine is acid, the quantity may not be great, but in the more severe cases, where the calculus is large or irregular in shape, and especially where the urine has undergone decomposition, and suppurative pyelitis is present as well, the discharge is profuse and loaded with crystals of triple phosphate. When this occurs other symptoms soon follow: the temperature rises, especially in the evening, sometimes as much as two or three degrees; headache and drowsiness are of common occurrence; the appetite fails completely; the tongue is dry and cracked; nausea is almost constant; and the patient rapidly loses flesh and strength.

Tenderness in the loins and *rigidity of the muscles* are always present. If there is more than one calculus, grating can sometimes be made out by deep palpation when the patient is under an anæsthetic. Enlargement of the kidney is more common; sometimes it is real, due to congestion; but more often it is caused by condensation of the fibrous tissue around from continued irritation; and not uncommonly it is only apparent, the kidney being dragged downwards by the spasmodic contraction of the muscular fibres of the ureter.

Diagnosis.—When there are repeated attacks of renal colic without the stone passing into the bladder, and apparently causeless vesical irritability, with the presence of blood and mucus in the urine, the diagnosis of renal calculus is easy. In many instances, however, it is a matter of the greatest difficulty. Nephralgia, closely resembling renal colic, may occur in delicate women during the menstrual period, from the physiological enlargement of the kidney; it may be present with hæmaturia in chronic interstitial nephritis; biliary colic and duodenal inflammation may imitate it closely on the right side; while there are many cases on record in which there has been great difficulty in distinguishing it from vesical calculus, lumbago, typhlitis, and even aneurysm.

Cancer and tubercle affecting the kidney are the most difficult, particularly in the early stages; renal colic may occur in both, due either to coagula or to broken-down caseous masses traversing the ureter; lumbar pain, hæmaturia, and vesical irritability are usually present; and in many cases there is nothing distinctive in the urine. In malignant growths, however, the hæmorrhage is usually profuse and is rather the cause of the colic; while in tubercular pyelitis the amount of pus is always greater than in the case of calculus, unless this is complicated by the presence of alkaline urine and septic decomposition; and true renal colic never occurs until the caseous masses have begun to undergo disintegration. Search should always be made for cancer-cells and for tubercle-bacilli; but unless the greatest precautions are taken they are very difficult of identification, especially the latter; and the fact of their not being found even after repeated examination cannot be regarded as evidence of their non-existence.

It is not uncommon for calculi to remain latent in the kidney for years without causing active mischief, and in many instances they have been found *post mortem* without their presence having been suspected during life. In the majority, however, they give rise to symptoms of greater or less severity; and in a very large number they lead to such extensive destruction of the kidney, and such serious interference with health and strength, that the question of removal becomes imperative.

It is least serious when the calculus is encysted in one of the calyces or fixed between the pyramids (fig. 396): the renal substance around becomes absorbed and indurated; a sac of dense fibrous tissue is formed; and the amount of interstitial connective tissue throughout the organ is increased; but provided the size remains moderate, and suppuration does not set in, the stone may remain quiet and undisturbed for years.

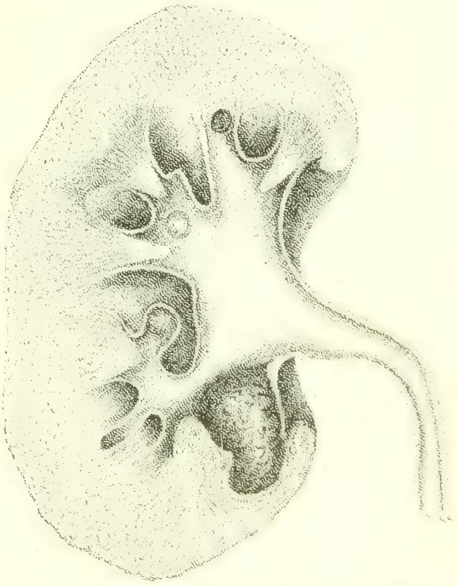


FIG. 396.—Calculus encysted in lower part of pelvis

Small calculi lying loose in the pelvis are infinitely worse. On the one hand they cause repeated attacks of renal colic, which end at length in hydronephrosis and interstitial nephritis; on the other, they set up acute inflammation of the pelvis, which spreads to the secreting tubules and finally destroys them. The mucous membrane first becomes irritated; then the apices of the pyramids disappear; the kidney substance s broken down and eaten away; and at length, partly by absorpion and dilatation, partly by ulceration and sloughing (especially after the urine has begun to decompose), a large irregular cavity is formed, in the entre of which lies the calculus, grown perhaps into a branching mass which almost fills the interior. In extreme cases nothing is left but a shapeless bag of pus, formed by the capsule and the fibrous tissue condensed together, with perhaps some shreds of cortex, coated with a slimy mass of phosphates, still left upon the inner surface (fig. 397).

Treatment.—In *acute renal colic*, the pain and spasm must be relieved with as little delay as possible, in the hope that the calculus may reach the bladder; as soon as it leaves the ureter, the symptoms begin to subside. Opium is of the greatest value, and, if the kidneys are sound, must be given freely, either the tincture mixed with an equal quantity of water, so that the amount of fluid is small, or morphia, with a minute quantity of atropia, hypodermically. Chloroform is of use when the spasm is severe, but the inhalation should not be prolonged. The bowels should be emptied at once with a hot-water enema, not only because this prevents the pain caused by the pressure of a loaded colon, but because it relieves the spasm of the ureter, and by the effort at expulsion helps the passage of the calculus; the patient should be placed in a full-length hot bath (temperature 98° F. gradually raised to 101° or 102° F.) for twenty minutes to half an hour; and if this does not soon give relief, the loins should be dry-cupped on both sides. Hot distilled water, or very weak tea, or barley-water may be taken freely; there is no object in limiting the amount if the patient can take it, but not unfrequently it merely increases the sickness.

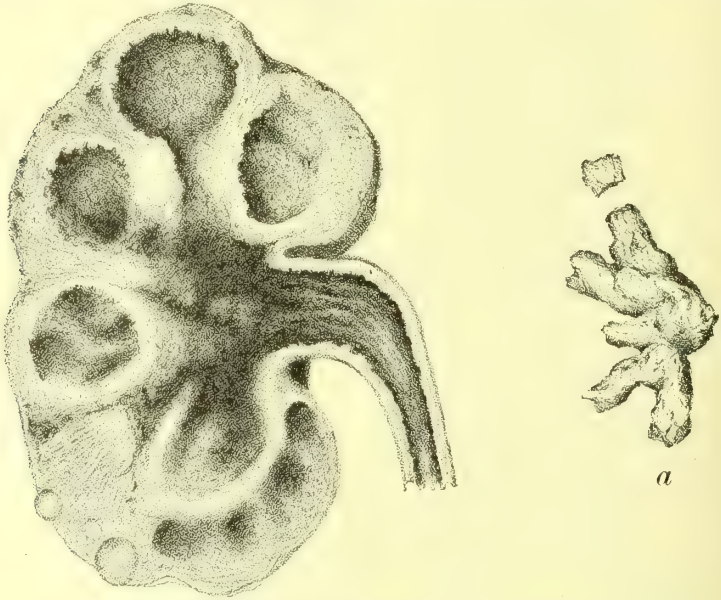


FIG. 397.—Suppurative calculous pyelitis with destruction of renal tissue. (*a*) The calculus removed from its bed.

Generally speaking, after twenty-four hours the paroxysms become less severe; if the stone passes into the bladder, they stop suddenly; if it remains in the ureter, they continue longer, and cease very gradually, often returning again in a milder form with the least movement. In either case the patient is left in a state of extreme prostration, utterly worn out; and though the colour may return, and the face resume its natural expression within a few hours, it is not unfrequently many days before the strength is regained and the patient is able to move about again without the dread of recurrence.

Impaction in the ureter.—The calculus may be arrested at any point, but nearly always it is either at the commencement, where the pelvis narrows into the ureter, or at the end, so that it projects slightly into the bladder. In the latter case it can be felt as a round, hard mass, through the wall of the rectum or vagina. In women the bladder can be explored with the finger under an anæsthetic; but in men, unless the stone projects so far into the cavity that it can either be seen with the endoscope or felt with a sound, this help is lost.

The treatment must be guided by the symptoms, and particularly by the condition of the other kidney. If the amount of urine secreted does not fail, manipulation may be tried under an anæsthetic; copious hot enemata may be given with opiates and warm baths; and if the calculus can be felt near the end, an attempt may be made to hook it down further by means of the finger, or to extract it through a suprapubic or a perinæal incision, making a small nick in the mucous membrane at the orifice if necessary. If the impaction is not relieved, the symptoms become less urgent as time passes, the colic subsides, the kidney wastes, and hydronephrosis follows.

It is much more serious when the other kidney is already disabled, whether this arises from a similar accident (which is not at all uncommon), congenital defect, or disease; the secretion of urine is then arrested altogether, and unless relief is speedily obtained, the condition must prove fatal. The same measures may be tried first, but if they do not succeed, either an incision must be made in the loin to drain the kidney, or the abdomen must be opened and the ureter traced until the obstruction is found. If the calculus is felt, the peritoneum and the wall of the ureter may be incised, the stone removed, the cavity cleansed, the wound in the ureter stitched together again, and the peritoneum united over it; or, if the obstruction is due to any other cause, it may be dealt with according to circumstances. Which of these operations should be performed depends upon the condition of the patient. The latter is the more thorough, and as both ureters can be examined, there is less likelihood of an operation on the wrong side, but it is the more serious; the former, unless the calculus is lying in the pelvis within reach, can only be regarded as a temporary measure, leaving behind it a renal fistula in the loins, through which the whole of the urine must flow.

In the pelvis.—A calculus in the pelvis may sometimes be so reduced in size by solution or disintegration, that it becomes small enough to pass through the ureter; or if this does not happen, it may work out a bed for itself, and become fixed by fibrous tissue, so as to give no further trouble. An operation should not be proposed until after the former of these, at least, has been tried.

Solution can only succeed with small calculi, composed of uric acid or urates; large ones are out of the question, and oxalate of lime, and substances deposited from alkaline urine, are not sufficiently soluble. It is of most service where small masses of uric acid are constantly being formed in the urinary tubules, and dropped into the pelvis, as in the case of the pisiform concretions of old people, causing them to be dissolved and wasted away before they get too large, and acting rather as a preventive means; but even after being in the pelvis some time, calculi can be so reduced in size as to pass easily down the ureter, or at least give no further trouble. The citrate and bicarbonate of potash, which are often given in large doses for this purpose, are not of much service by themselves; the urine must be very concentrated for them to have any effect, and as the alkaline fluid simply passes over the surface of the calculus, the chance of any appreciable solution is exceedingly small. Moreover, there is the danger that, if large or long-continued doses are taken, the urine may become too alkaline, and deposit a layer of phosphates. Distilled or soft water, on the other hand, taken in large quantities, four to five pints a day, with occasional doses of citrate of potash, or of some alkaline water, such as that of Vichy or Contrexeville, is often most effectual. The specific gravity of the urine is diminished; the rate of secretion is increased; it acts to a slight extent as a solvent; and, what is of more importance, by diminishing the amount of inorganic material, it assists the disintegration of the external laminæ; but for this to answer, the treatment must be continued for a considerable length of time, the urine must never be allowed to become concentrated; and the diet must be carefully restricted. Fish and white meat are to be preferred; sweet fruits, especially cooked sugar, and rich pastry, should be avoided; bread should be toasted; and the amount and kind of alcohol carefully prescribed. Probably patients with renal calculi would be better without any; but in many instances they are so worn out by suffering that depriving them of it altogether would prevent their digesting anything else. Beer and strong wines, containing large quantities of sugar, are certainly injurious; but the lighter ones, or small quantities of spirits, well diluted, and taken with the meals, may generally be allowed.

Small doses of turpentine, given either in the form of emulsion or, better, in capsules, are of great use in these cases: not unfrequently a large amount of gravel is brought away in a very few days. Probably this is due to the effect that the turpentine has upon the lining membrane of the pelvis: the secretion of mucus is checked; the growth of the calculus is arrested; and the size of the passage through which it has to pass is materially increased by the diminution of the hyperæmia and swelling.

Encystation.—If the calculus is too big for solution, and the condition of the patient precludes operation, an attempt may be made to mitigate the evil by assisting the calculus to form a bed for itself. This sometimes takes place accidentally; and Ralfe has shown that it can be done, if only the patient will put up with the irksomeness of prolonged rest. The same position, generally dorsal with a little inclination to the affected side, must be maintained for several months, without moving. At the end of that time a little more freedom may be allowed, and then by slow degrees, the patient may sit up and walk about; but riding or jolting must be strictly avoided; the whole benefit may be lost by a moment's thoughtlessness.

If these measures fail, and if there is either a small calculus constantly rolling about, or a large one gradually destroying the kidney, an attempt should be made to remove it by operation. In the one case it will, if left to itself lead, after repeated attacks of renal colic, to interstitial nephritis and hydronephrosis, with, very possibly, if it occurs on both sides, suppression of urine; in the other it will end at length in septic decomposition and suppuration, which will spread from the pelvis to the kidney and destroy it.

Inflammation of the Kidneys

Inflammation of the kidneys may be either primary (nephritis), or secondary, due to extension from the pelvis (pyelonephritis).

1. *Acute nephritis* is not common in surgery, but it may be caused by exposure to cold and wet, by extensive lesions of the cutaneous surface, and by irritating substances in the urine, such as cantharides or turpentine. Mild forms are occasionally met with in erysipelas and, very rarely, in secondary syphilis.

Pathological appearance.—The kidney is swollen and rounded the veins are prominently marked; the capsule strips off readily, and when it is cut open the surface is deeply congested; it may even drip with blood. In milder cases, where the symptoms have lasted longer, the cortex is paler, owing to the great increase in the epithelial elements in the tubules, and the contrast of the pyramids is still more marked.

Symptoms.—Acute nephritis may set in with a rigor. The temperature may reach 103° F. the first day; headache, vomiting, insomnia, and loss of appetite, are always present; the pain and aching over the loins never cease; often there is the most intense desire to micturate; the quantity of urine is greatly diminished; in severe cases there is almost complete suppression; the specific gravity is high; it is loaded with blood and casts; and it nearly always throws down a turbid deposit of urates, epithelium, and broken-down corpuscles. If the inflammation is severe and the excretion of urine seriously checked, dropsy may set in within twenty-four hours; more frequently it does not appear until the second or third day. Sometimes there is only puffiness about the eyelids; sometimes, on the other hand, there is general anasarca invading the serous cavities, and even causing death from œdema of the glottis.

Treatment.—The chief object is to reduce as far as possible the amount of work, and to relieve the congestion. In mild cases it is sufficient to keep the patient warm in bed, at an even temperature, with the bowels relaxed and the diet restricted; in more severe ones great relief may be obtained by the use of hot-water and vapour baths. Cupping over the loins is often beneficial; and where the fever is high, and the patient young and vigorous, venesection may be performed with advantage. The bowels should be opened with castor-oil, or a small dose of calomel, and then kept relaxed with sulphate of magnesia; it is doubtful if strong hydragogue purgatives do not do more harm than good. Nitrogenous food should be excluded from the diet, at any rate for the first few days; after that small quantities of milk may be allowed; but eggs, and other articles of food that consist largely of albumin, should be forbidden. As the symptoms subside, great care is necessary, both with regard to this and to the temperature; relapses very easily occur, and there is great danger, if the symptoms persist for any length of time, that the condition may become chronic.

2. *Chronic nephritis.*—Chronic interstitial nephritis is much more common and is most important; on the one hand it impairs general nutrition to such an extent that the tissues slough with the least injury; on the other hand it so predisposes the kidneys to the influence of shock that any operation upon the urinary organs is very liable to be followed by complete or partial suppression of urine.

It may follow an acute attack; or be caused by the same influences (such as cold, wet, exposure, or irritating conditions of the urine), acting with less intensity but greater persistence; or it may be the consequence of certain morbid conditions of the bladder or urethra.

One of these is an impediment to the outflow of urine. Whenever this occurs, whether it arises from stricture, enlargement of the prostate, or any other cause, tension is exerted on the part behind, and this leads to a certain degree of dilatation and chronic inflammation. Even undue frequency of micturition, such as is met with in vesical calculus, is sufficient.

This, however, is not the only one. Chronic inflammation (without dilatation) may be caused in an entirely different way. The passage of a catheter is followed in many people by sudden congestion of the kidneys; as a rule this subsides of itself; but if it is frequently repeated, or if there is a stricture in the deeper part of the urethra, causing a certain amount of spasm every time the urine passes over it; or a vesical calculus constantly falling against the neck of the bladder; or if the urethra is in a state of chronic inflammation from repeated attacks of gonorrhœa, this congestion practically becomes chronic; the connective tissue grows more dense and fibrous; the vitality of the epithelium is impaired; and the kidney becomes small, hard, and cirrhotic. It must remain in most cases uncertain how far this disease of the kidneys is the result of tension only, and how far it is due to the chronic congestion; but this is certain, that no condition of the bladder or urethra which interferes in any way with their proper function can exist for long without producing a most serious effect upon the kidneys.

The pathological appearances depend to some extent upon the degree of obstruction. The kidney is generally smaller than natural, hard, and dense: the surface is irregular; the capsule adherent, so that it tears away with it small portions of the tubules; the cortex thinned and wasted, with small cysts scattered through it; and the pyramids flattened and compressed. The pelvis may be normal, but, especially in those cases in which the interstitial growth is due to obstruction, it is dilated and there may be every degree, from incipient fibroid change with slight expansion to extreme hydronephrosis, with nothing left of the kidney but a thickened disc of connective tissue.

Symptoms.—When fully developed these are characteristic; in the early stages the patient seldom comes under notice. There is a slight but distinct failure of strength; the skin is dry and harsh, itching constantly; headaches are of common occurrence; occasionally there are attacks of vomiting; neuralgia is not infrequent and is often very obstinate; the patient grows thin and pale, and sometimes hypochondriacal; there is loss of sexual power and very generally increased frequency of micturition, especially at night. The pulse is full and incompressible; the left ventricle is hypertrophied; there is a tendency to epistaxis, and other hæmorrhages; and in the final stages a certain amount of œdema.

The urine is greatly increased in quantity and its specific gravity is exceedingly low: the colour is generally bright and there is rarely much deposit, though a very few casts with some epithelial cells and crystals of oxalate of lime are occasionally to be found. Very often there is no albumin, but as the disease advances, especially if the amount of urine begins to fail, it may make its appearance, though never in any large quantity.

Towards the end hæmorrhages occur, in the retina among other places; visceral complications arise and the patient may be carried off by pleurisy or pneumonia; œdema sets in; the vomiting becomes more frequent; muscular twitchings make their appearance and grow worse and worse, until at length uræmic convulsions and coma end the scene.

Treatment.—The first thing is to remove the cause, whether it is stricture, calculus, or anything else. It is true that the risk of shock and suppression is very much greater than in ordinary circumstances, but waiting longer than is absolutely necessary to bring the patient into the best condition will not make it less. After this has been done the kidneys must be saved as much as possible and protected from injurious influences. Iodide of potash and bichloride of mercury in very small doses may have some influence in checking the hyperæmia and assisting the absorption of the lymph if given before the contraction is too dense ; and in the later stages chloral allays the irritability of the skin and checks muscular twitching. Most reliance, however, must be placed upon rest, warmth and diet. During the subacute attacks that are frequently present the patient should be confined to bed ; exertion, both mental and bodily, should be avoided ; long railway journeys are particularly injurious ; the clothing should be warm ; damp and chilly residences are especially injurious ; the diet must be light but nutritious ; alcohol should only be taken so far as is necessary for digestion ; eggs and other substances that contain a large amount of albumin should be partaken of very sparingly ; milk may be allowed freely, especially with farinaceous food and the lighter forms of meat ; but great care should be taken not to overload the digestive organs or to run the risk of causing dyspepsia.

Pyelitis and Pyelonephritis

Inflammation of the mucous membrane of the pelvis of the kidney is rarely met with by itself. Except in the mildest cases, such as those caused by the accumulation of gravel in gout, the kidney almost always becomes involved before the disease has lasted any length of time ; and in those in which suppuration breaks out its whole substance may be destroyed, nothing being left but a sac distended with pus, with scarcely a trace of the original structure visible.

Causes.—These are almost the same as those of inflammation of the bladder. Cold is occasionally one. Injury is more common, whether it is mechanical, due to the irritation of a calculus, or chemical, arising from the action of noxious substances in the urine. Tubercle is not at all rare, while, in exceptional cases, new growths, carcinoma, and villous tumours similar to those in the bladder, have been the cause. Finally, it is often due to extension, especially from the ureters. At first, the inflammation is limited to the pelvis, but if the cause is a large calculus with spreading branches, or if it is foul and septic urine, or if the deposit of tubercle, instead of being confined to the pelvis is scattered through the substance of the organ, the kidney rapidly becomes involved as well, and in a very short time the whole of it is either riddled with minute abscesses, or converted into a suppurating sac. Sometimes the ureter is obstructed, so that the pus is unable to escape, and then a huge swelling, *pyonephrosis*, forms in the loins. In very rare cases the closure is incomplete, and there is an intermittent discharge of fluid, as occasionally happens with hydronephrosis.

Pathological appearances.—These differ very considerably. *In simple catarrhal pyelitis*, the mucous membrane is swollen, thickened, and redder than natural ; the surface is raw from the loss of its protecting epithelium, and in severe cases is coated over with lymph, mixed perhaps with blood. Sometimes there are older, darker extravasations, and when the disease is of long standing the colour *post mortem* may be almost black.

In *calculous pyelonephritis*, when the stone is the only cause, the mucous membrane may show no further change; or, if the irritation has been of long duration, the substance of the kidney may be eaten away—the medulla especially having suffered—and the interstitial connective tissue thickened and hardened. Unfortunately in most cases the urine decomposes and suppurative pyelonephritis makes its appearance in addition. When this occurs the mucous lining becomes thickened, ulcerated, and coated with a slimy deposit of pus and phosphates; the whole of the medulla, and most of the cortex, are eaten away; and nothing is left but a large irregular cavity full of foul and decomposing pus, with roughened and rugged walls lined with the débris of the broken-down and ulcerated cortex (fig. 397).

Tubercular pyelonephritis may occur in the course of general miliary tuberculosis, or at first, at least, as a local affection. In the latter case it may begin in the bladder or in the kidney; but often, before the disease has lasted any length of time, it extends from one to the other, and not unfrequently involves both the kidneys, although in different degrees. In the earlier stages the mucous membrane of the pelvis is thick and soft, and the surface like sodden wash-leather; here and there are small superficial ulcers with sloughing and ragged edges, due to the breaking-down of the caseous deposit; the pelvis is enlarged, owing to the increased difficulty in the discharge of the urine; and, according to the situation of the growth, there are either numerous small caseous foci in the substance of the kidney, or the apices of the pyramids are eaten away. When the disease is of longer standing, the tissue around the kidney is condensed and indurated; the capsule is thickened and cannot be separated from the cortex; the medulla is almost destroyed, and the cortical part is softened and disintegrated (fig. 398). Ultimately suppuration occurs, as in other forms of advanced pyelitis, and the whole of the renal substance may disappear and nothing be left but a thickened shell of fibrous tissue, preserving somewhat the shape of the kidney, filled with a slimy mass of tenacious pus, like soft putty.

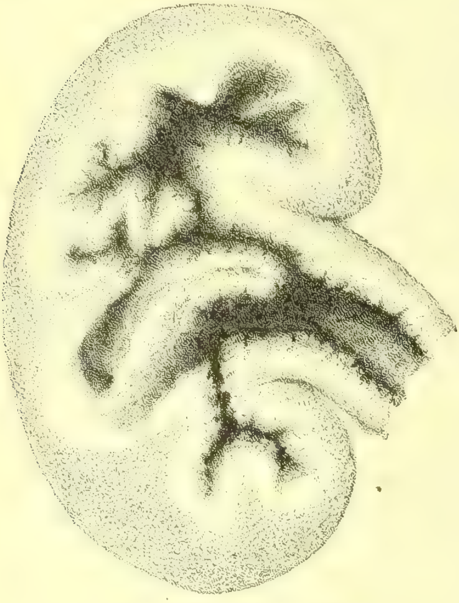


FIG. 398.—Tuberculous pyelonephritis.

Suppurative pyelonephritis (surgical kidney, so-called), such as is met with in old cases of stricture, vesical calculus, or enlargement of the prostate, after ammoniacal decomposition of the urine has set in, has already been mentioned. The kidney is generally small, hard, contracted and granular from the pre-existing interstitial nephritis; minute abscesses, each surrounded by its zone of congestion, are present in numbers under the capsule, or buried in the cortex, or extending as long, slender streaks in the substance of the pyramids: here and there between them are points where the inflammation has not yet culminated in suppuration; the apices of the pyramids are eaten away: the pelvis and calyces are irregularly dilated from the old-standing obstruction; and the mucous membrane is discoloured, ulcerated, coated over with stinking pus, and even sloughing. Decomposition has occurred in the bladder and caused acute cystitis; and the poison has spread directly upwards to the pelvis and into the substance of the kidney. Very rarely the pelvis is healthy, in spite of the presence of advanced nephritis, the germs having, in all probability, gained the kidney by spreading along the lymphatics of the ureter and the capsule, until at length they reach the interstitial spaces that lie between the tubules and surround the glomeruli.

Symptoms.—Pyelitis may affect one or both kidneys, according to the cause. When it is due to septic urine and cystitis, it is nearly always bilateral; the tubercular form may begin in one, but very often it extends to the other at an early period; and though the retention of calculi in the pelvis is in some measure the result of accident, their formation is due to constitutional causes, and if they are present on one side there is very great probability of their occurrence on the other.

Local.—In the early stages the symptoms of pyelitis are very indefinite, unless the attack is acute, or there is a small calculus dropping constantly into the orifice of the ureter; in the chronic forms, at the commencement of tubercular disease for example, they may be entirely wanting. As the inflammation spreads and involves the kidney, there is a constant dull aching in the loins; the muscles are rigid and tender; there is stiffness on moving, and not unfrequently either diarrhœa or constipation. In the later stages of calculous and tubercular disease, when the tissues around are involved as well, the pain may be exceedingly severe, and the kidney may feel as if it were enlarged; but there is rarely any distinct swelling unless the ureter is closed and pyonephrosis has set in.

Neuralgia radiating down some or all the branches of the lumbar plexus, into the groin, down the inner side of the thigh, or into the testicle, is always present, and is often severe when there is a calculus. Irritability of the bladder is almost as general; in renal tuberculosis it is one of the earliest signs, and it is not uncommon for the bladder to be sounded time after time for stone, especially in children, before the real cause is detected. In the later stages it may be simply agonising.

The character of the urine is most important. In simple catarrhal pyelitis it is acid, and varies but little in quantity or specific gravity; but it is turbid, and yields on standing a sediment, in which the characteristic spindle-shaped or caudate cells of the pelvis can be detected. Blood-corpuscles are generally present if there is a calculus, but in the other forms they often do not appear until later. As the case progresses the epithelium disappears, the amount of mucus increases; and this in its turn is replaced by pus, which may be present in such quantity as to form a thick creamy deposit at the bottom of the vessel.

In tubercular and calculous pyelitis, the urine may continue acid quite to the end, in spite of the amount of pus that is added; in the septic form, on the other hand, it is alkaline and ammoniacal, and the pus, mixed with phosphates, forms a dense viscid gelatinous mass, similar to that secreted by the bladder under the same conditions.

Constitutional.—These depend partly upon the amount of suppuration, partly upon the extent to which the renal substance is involved, and whether both kidneys are implicated or only one.

In the so-called surgical kidney, consequent upon vesical disease, the symptoms are essentially those of chronic nephritis, with partial and increasing suppression. There is rapid emaciation, with loss of strength, dryness of the skin, headache, neuralgic pains and vomiting. The pulse is small, quick, and feeble; the temperature rises to 102° F. or 103° F.; rigors occasionally occur; and the patient gradually passes into a dreamy state, with low muttering delirium, until diarrhœa with a subnormal temperature, or coma, and perhaps at length convulsions, follow.

In tubercular and calculous pyelonephritis, if only one kidney is affected, the other may become hypertrophied, and, so far as the urinary secretion is concerned, compensate perfectly; and sometimes when this occurs the pus dries up (especially if the ureter becomes blocked), and the kidney is at length converted into a pasty, mortary, or even calcareous mass, surrounded by a fibrous capsule. Much more often, however, suppuration sets in, and symptoms similar to those present in any case of ill-drained abscess make their appearance; the temperature rises, especially towards evening, or rigors occur; the patient becomes weak and feeble; night sweats and diarrhœa begin; and either hectic or amyloid disease, which is especially serious when there is only one kidney active, follows.

If both kidneys are affected, not only are these symptoms greatly intensified, but in addition the amount of urea and the specific gravity of the urine fall lower and lower until at length it ends in suppression.

Diagnosis.—The diagnosis of pyelitis at its commencement is often very difficult, and rests chiefly upon the irritability of the bladder, for which no cause can be found, the shape of the epithelial cells in the sediment, the amount of mucus in the urine, and the character and locality of the pain. When cystitis is present as well, as it not unfrequently is in gout and tubercle, the difficulty is greater still. In older cases, when the kidney becomes involved, there is little or no trouble; either the urine continues acid in spite of its containing an enormous amount of pus; or, if it becomes alkaline and ammoniacal, the diminution in the amount of urea, the low specific gravity, the emaciation, and the other constitutional signs, render it clear that the disease, though it may affect the bladder, is not confined to it.

Calculous pyelitis may generally be distinguished from the others, by the severity of the pain, the way in which it radiates down to the testicle, the occurrence of renal colic, the effect of exertion, and the presence of blood-corpuscles in the urine at a very early period. When the inflammation is due to gravel, genuine colic is rare, though there may be a great deal of pain; and the urine is of high specific gravity, very acid and loaded with crystals. In either case, the history, the other constitutional symptoms, and the occurrence of previous attacks, are of great importance.

Tuberculous pyelitis is more difficult to distinguish, especially at the beginning, for though caseous masses and bacilli may be found in the urine when the disease is advanced, they are seldom present until the kidney itself begins to break down. Very often the diagnosis has to be made by a process of exclusion; there is great irritability of the bladder, without anything local to account for it; the amount of mucus in the urine is undoubtedly excessive; blood is seldom present; the pain is not severe; there is no renal colic; and the urine does not contain either uric acid or oxalate of lime in excess. In these circumstances, the presence of tubercle elsewhere, especially in connection with the genito-urinary organs, must be regarded as of the gravest significance. Later, the amount of pus, the presence of caseous masses and of bacilli, and the acid reaction of the urine, are distinctive; but this does not prove that both kidneys are not involved.

Pyonephrosis can only be distinguished from hydronephrosis, of which it is not an infrequent termination, by the pain, fever, and rigors, which occur with more or less severity. In the case of perinephritic abscess, the shape and the outline of the swelling are not so distinct; and the urine is not affected. Other abscesses in the same region, due to disease of the vertebræ, cæcum, or liver, or even to an empyema working its way down, rarely present any difficulty.

In a very few cases the discharge of pus is intermittent, and there is a proportionate variation in the size of the tumour.

Treatment.—The treatment of calculous pyelitis and of that which is due to the presence of uric acid has been described already. If there is a stone, an attempt must be made either to procure its disintegration or to fix it in some outlying part; if this fails, and it continues to give inconvenience, it should be removed by operation, and afterwards the diet and mode of life regulated, so as to prevent concentration of urine and the accumulation of uric acid.

When the pyelitis is due to decomposition of urine in the bladder, the growth of the ferment must be stopped by antiseptics and drainage. Meantime, every attempt must be made to restore the acidity of the urine, as this is a serious hindrance to the micrococcus, and to spare the kidneys as much as possible and economise the patient's strength by carefully dieting and attention to the action of the skin and bowels.

The treatment of tuberculous pyelonephritis depends upon whether it is merely part of a general tuberculosis, or of an affection of the whole urinary system; or whether it is a local disorder, and still confined to one kidney. In the former case only palliative treatment is available; the strength must be maintained; the intense vesical irritation must be relieved by morphia; and any symptoms that arise must be met by suitable measures. Median cystotomy and drainage, which are of such service when the strangury is due to local causes, such as malignant disease of the bladder, are useless, when it is dependent upon the reflex action of the nervous system.

There is more hope when it can be shown that the affection is limited to one kidney, as it is in about half the cases, though it is very difficult to prove. The specific gravity of the urine may be good; the amount of urea may not be below the normal; and there may be an entire absence of pain on the opposite side of the body; but, unless the urine can be collected from the ureters separately, in sufficient quantity to be examined, it is not possible to be certain. In some of these cases the pus gradually dries up, the ureter having been accidentally blocked in some way; for it is not uncommon, *post mortem*, to find kidneys consisting of nothing but a capsule full of calcareous or cheesy mortary substance, years after all symptoms have subsided. This, however, cannot be relied upon: the disease is much more likely to prove fatal by involving the ureter or other organs near, from general miliary tuberculosis, or after prolonged suffering, from hectic and exhaustion. Whether nephrotomy and drainage, or nephrectomy and removal of the whole mass, afford the best prospect of relief, depends upon the circumstances of each case. If the patient is too exhausted to withstand the shock of the major operation (and it often happens, from the dense adhesions between the capsule and the surrounding structures, that a very long time is required for complete enucleation), or if there is any doubt as to the condition of the opposite one, nephrctomy is the more suitable. If there is any need for it, the shrivelled and contracted sac can be removed afterwards. Where, on the other hand, there is nothing left but a fibrous sac without, when it is laid open, any trace of secreting structure, and where the adhesions can be broken down without unduly prolonging the operation, there is no object in leaving it to be completed at a later date.

PERINEPHRITIS

Inflammation of the cellular tissue around the kidney is occasionally primary, caused by injury or exposure to cold; much more frequently it is consecutive to disease elsewhere. Sometimes, as in calculous and tubercular nephritis, it arises by direct extension from the kidney, the pus gradually making its way through the capsule, and bursting, perhaps externally, so that the stone is discharged through an opening in the loins; sometimes it originates from inflammation about other structures near—the colon, cæcum, liver, or even the vertebræ. In a large number of cases it is due to the inflammation of the pelvic cellular tissue extending upwards, after wounds of the lower part of the vagina or uterus; after childbirth; or after operations upon the testicle, spermatic cord, or rectum; and, finally, it may be pyæmic in character, following one of the acute exanthemata.

Perinephritis is sometimes chronic, the capsule and the cellular tissue becoming thicker and denser, until the kidney is invested in a dense fibrous wall which cuts and feels like cartilage; but, as a rule, suppuration soon sets in, and a large irregular abscess forms around the kidney, and spreads upwards and downwards as far as the yielding character of the tissues will allow. The kidney itself, unless the suppuration originated in it, usually shows no change; but, occasionally, the cortex is softened, in a state of cloudy swelling, and even filled with minute abscesses. Both sides may be involved, especially when it is the result of pyæmia.

Symptoms.—The early ones are very perplexing: very often there is a rigor at first, with constant vomiting; the temperature is very irregular; the bowels are obstinately constipated; there is a dull aching pain across the back, and the patient feels perfectly crippled. The body is inclined towards the affected side, and slightly bent forward; the thigh is flexed upon the abdomen, and the leg is rotated outwards, as in the second stage of hip-disease. The least movement makes the pain tenfold worse, and causes it to radiate down the lumbar plexus, but especially into the groin and the testicle; and with all this, the urine is either perfectly normal (unless, of course, there is calculous pyelitis), or, in some exceptional instances, contains a certain amount of albumin and a few tube-casts. After a time, the tenderness in the loin becomes more localised; there is a sense of deep resistance, on palpation; and the skin becomes shining and œdematous, or even reddened; though fluctuation is seldom to be felt, even when the abscess contains several pints of fluid. If the case is left, and the constitutional disturbance does not prove fatal, the abscess either points over the crest of the ilium, between the obliquus externus and latissimus dorsi, or else extends under Poupart's ligament into the thigh. In a few rare cases it has been known to burst into the lungs (so that an enormous amount of pus was suddenly coughed up), the intestines, the peritoneal cavity, or even the ischiorectal fossa.

Diagnosis.—Perinephritis and perinephritic abscess are usually much more acute than hydronephrosis, pyonephrosis, and the other diseases that cause enlargement of the kidney, and are not so sharply defined in outline. At first there may be some difficulty in distinguishing it from perityphlitis, and even from enteric fever; and it has been confused with hip-disease (owing to the position of the limb), with caries of the spine, lumbago, fæcal accumulation in the colon, and with abscesses resulting from disease of other neighbouring structures.

Treatment.—When the attack is subacute, an attempt may be made, by applying leeches and poultices, and by keeping the patient at rest, to procure resolution, but the result is rarely satisfactory. As a rule, rigors occur early, and mark the beginning of suppuration. The bowels should be well cleared out; hot-water enemata are often of some relief; the pain should be controlled by opium and belladonna; and as soon as suppuration is suspected, an exploratory puncture should be made with an aspirating needle. In a very few instances, if the abscess is emptied in this way, recovery takes place without incision; as a rule, it is necessary to open it freely, wherever it is most prominent, and insert a large drainage-tube.

URINARY FISTULA

Fistulous channels discharging urine, pus, or both together, are sometimes formed in connection with the kidney, its pelvis, or the ureter; and they may discharge either externally in the loin; or on the front wall of the abdomen in the inguinal region; or into one of the neighbouring viscera, the uterus or vagina most commonly, the stomach, intestine, and pleura very rarely.

The most frequent cause is calculous pyelitis leading to suppuration outside the kidney; after the abscess has been opened the passage contracts down to a sinus, the walls of which are lined with a kind of granulation tissue, and perhaps coated over with phosphates. It may result, however, from gunshot wounds or other injuries, from operations about the female pelvic organs, especially hysterectomy, and, occasionally, from tubercle. In some cases, as in cystic disease of the kidney, and hydronephrosis, a urinary fistula is formed as a temporary expedient where it is not possible to obtain at the time exact information as to the condition of the opposite organ.

After nephrotomy or nephrolithotomy, where the kidney is healthy and there is no obstruction in the ureter, the wound, though it may continue to discharge urine for a week or two, usually closes of itself. If it persists injections of iodine may be tried, or nitrate of silver fused upon a probe, or even a heated wire. When, however, in addition to the urine, there is a profuse discharge of pus, so that it is certain that the kidney is extensively disorganised, and there is fear of amyloid degeneration, or where the fistula is a source of intense annoyance and distress, and it can be proved that the opposite kidney is sound and not the seat of calculous disease, the best plan is to perform nephrectomy.

It must not be forgotten that fistulæ connected with the bladder and the urethra have been known to open in the inguinal region, and even in the loin. In case of doubt the diagnosis can always be confirmed by the injection of milk or other coloured fluids into the bladder.

Methods for Distinguishing the Secretion of the two Kidneys

In all operations about the kidneys, but especially when nephrectomy is contemplated, it is of great importance to obtain definite information with regard to the secreting power of each of them. As already mentioned, it is not uncommon to find that, as a result of congenital defect, accident or disease, one kidney is either actually non-existent or else is so small as to be practically useless. Even in the abdominal operation this is not unnecessary, for all that can be ascertained by this is the size of the organ in question; it tells next to nothing about its condition.

Various methods have been devised, but none is satisfactory. The simplest is that suggested by Polk: one of the ureters is compressed just before its termination, between a piece of block-tin, shaped like a catheter with a very sharp curve, introduced into the bladder, and two fingers placed in the rectum; or, if it is preferred, a curved spatula with a suitable groove on its upper surface. As soon as this is secured in position, the bladder is washed out, and the urine from the other ureter allowed to collect, but it is very difficult to obtain more than half an ounce in an hour.

Catheterisation of the ureters can be managed in women either with the aid of the electric-light, or, the patient being in the lithotomy position, by placing the fore and middle fingers of the left hand in the vagina, one on either side of the os uteri, to which the orifices of the ureters nearly correspond, and, with these as a guide, manipulating the catheter with the other. On one occasion I slit up the urethra so as to expose the orifices more thoroughly. If catgut sutures are used, no incontinence should follow. Even in women, however, this will not always succeed, and in men it is out of the question.

The left ureter may be compressed at the brim of the pelvis by means of Davy's lever introduced into the rectum; the right cannot, unless there is a mesorectum. Even when used for a short time, however, this is not without risk; very serious bruising of the mucous membrane has occurred, although it was not possible to assert that too much force had been used; and certainly it would not be advisable to keep up a sufficient degree of pressure for an hour. The same may be said of the various attempts that have been made to secure the orifices of the ureters either by clamps shaped like a lithotrite introduced into the bladder, or by suction applied to the orifices of the ureters: they have only met with very partial success. When there is renal hæmaturia, the cystoscope is of some service; the jet of blood-stained urine may be seen emerging from the orifice of one of the ureters, but, unfortunately, it does not seem probable that this will be of much avail in the class of cases that need it most.

OPERATIONS UPON THE KIDNEY

PUNCTURE OF THE KIDNEY

The chief use of this is for diagnosis ; it may, however, be required either as a palliative or as a permanent measure in cystic disease, hydatid cysts, and even in cases of hydronephrosis. The aspirator should be introduced into the most prominent portion of the swelling, where the fluid seems to lie nearest the surface, taking care to ascertain the position of the colon first by inflation, if necessary.

NEPHROTOMY

Incision of the kidney may be required for suppuration, consequent on calculous or tubercular disease (usually as a preliminary to further measures) ; for renal retention (when the ureter is blocked) ; or for hydronephrosis. In many of these cases puncture will have been performed first, and the more severe and radical measure is only adopted either because the milder plan has failed (perhaps in spite of repetition) or because the condition it has revealed is such as to require more active treatment. An operation of a closely similar character is necessary in cases of perinephritic suppuration.

The incision is always lumbar, and usually oblique, parallel to the last rib, and an inch below it. The skin, superficial structures, muscles and aponeurosis are divided, as in colotomy, and the kidney exposed. If it is distended into a sac this should be opened either with a director and sinus-forceps, or with a scalpel, according to the condition found, and after the contents have escaped, the space left should be explored with the finger to ascertain if there is any persisting cause, and drained. If, on the other hand, it is a case of renal retention, the cortex (which is always hard and congested) or the pelvis must be opened sufficiently freely to allow the urine to escape.

NEPHROLITHOTOMY

There are two methods of approaching the kidney for this purpose, either from behind, in the lumbar region, or through the abdomen. That the former is the more suitable in cases in which the symptoms are definite and point plainly to one side, there can be no doubt, but it is still an open question whether abdominal exploration is not advisable in some as a preliminary. A certain amount of information can be obtained as to the condition of the opposite kidney ; the position of the stone, whether it is in the ureter or not, may be ascertained ; and there is less risk of an operation on the wrong side. Moreover, it is possible when operating through the loin to be misled by the presence of a perinephritic abscess, the interior of which is often divided into chambers like a sacculated kidney ; and it has happened before now, in the case of a very large and somewhat diseased kidney, that the finger has never entered the pelvis at all, but detached the thickened mucous membrane from the pyramids until a cavity was made, closely resembling the true pelvis. As, however, a calculus cannot always be felt after the kidney has been removed, even the combined abdominal and lumbar method does not ensure perfect certainty.

The patient lies upon the opposite side with a firm cushion under the flank. The kidney is supported from the front and pressed into the loin by an assistant; but if the walls of the abdomen are rigid and dense with a thick layer of fat, it answers better, as soon as the kidney is exposed, to roll the patient nearly on to his back again, so that the convex surface may drop of itself upon the finger. An oblique incision, four inches long, parallel to and an inch below the margin of the last rib, is the most convenient. It should commence at the outer edge of the erector spinæ, and should not come closer to the rib for fear of wounding the pleura, which sometimes descends as low as this. The superficial muscles are divided; the lumbar aponeurosis, which here is very thick, cut through upon a director, additional space being obtained, if necessary, by section of part of the quadratus lumborum, and the circumrenal fat exposed. Any point that bleeds should be tied at once, but generally there is nothing that requires it.

As a rule, the tissue around the kidney is so loose and soft that it can be separated easily with the finger and a pair of forceps; sometimes, however, when there has been much inflammation, it is tougher; and in old cases of suppurative pyelitis it may be exceedingly dense. As soon as the convex surface is exposed, the kidney must be thoroughly and systematically explored, first on the outside, passing the finger over the anterior surface and hooking it forwards into the wound until the pelvis is reached; then, as far as possible on the posterior, the fore and middle fingers passing behind it, while the thumb rests on it in front until it is fairly grasped. If nothing is detected in this way, no irregularity of surface or sense of resistance, the next step is to explore the substance of the kidney with a short stout needle set in a handle. It should not be more than two and a half inches long, for fear of wounding the vessels at the hilum. A number of punctures is made with this all over the cortex, always pointing in the direction of the pelvis. Sometimes a calculus is struck at once, but, especially when it is small, and it is often no larger than a pea, such good fortune is exceptional. If it is felt, the needle is used as a director; an incision is made by the side of it with a sharp scalpel, and a pair of long forceps, like polypus-forceps, passed along it until the blades are in a position to grasp the stone.

Where this does not succeed, the pelvis should be explored with a sound similar to that used for a child's bladder, but with a shorter beak. It is passed through the cortex into the lowest part of the cavity, and the whole interior and all the calyces systematically examined, the sound being carried at once to the upper end, a distance of nearly four inches, and working gradually down. Finally, if this fails, the finger must be used in the same way, introducing it through the same opening, and gradually dilating and tearing the kidney substance. The bleeding at the moment is tolerably free, but the pressure of the finger soon arrests it.

With a large branching calculus there is rarely any difficulty; when it is small, detection is often impossible. On one occasion I felt a small movable stone distinctly with the needle, but was quite unable to detect it afterwards with the sound, forceps, or finger. Another case is recorded in which the kidney was excised, and afterwards a stone was found in it, so buried that it could not be felt from the exterior, even after the organ had been removed. In a third case the calculus is reported to have come away subsequently in the dressings; and there is a very large number on record in which no trace of a calculus was found. Fortunately the operation is one that, so long as the stone is small, is very rarely followed by serious consequences; and in most cases, even when nothing has been found, the relief has been complete, probably from the calculus becoming fixed in the substance of the kidney by inflammatory adhesions or cicatricial tissue.

Great care should be taken to extract the stone without breaking it, and, especially in the case of large ones with long slender branches, this may be a matter of some difficulty; and after this is done the interior of the cavity must be thoroughly explored to see that nothing is left.

The treatment of the wound is very simple. A large drainage-tube should be passed into the kidney, so as to carry away at once all the urine that is secreted, and the fascia lumborum sutured with catgut, leaving only an orifice at the posterior angle for the drainage-tube. Usually the wound heals without suppuration. The tube should be removed the next day to clear it of any coagula, and introduced again down to the surface of the kidney; the third or fourth day it may be shortened so as to project only through the opening in the fascia. The urine passed by the bladder generally contains a large amount of blood for the first two days, then it should become clear. Retention is common at first, and may continue so long as the tube is in contact with the kidney. A urinary fistula persists for a week or two in the loin; but if the kidney was healthy and the ureter is not blocked, it generally closes of itself.

In cases of calculous pyonephrosis, when there is a large tumour in the loin, and the urine is loaded with pus, nephrotomy or nephrolithotomy should be adopted in preference to nephrectomy. It is true that the statistics of the latter operation under these conditions are more favourable, but, as Brodeur has pointed out, it is almost impossible to form a definite opinion as to the condition, or even the existence of the opposite kidney. Later, when the patient has rallied, and it is clear from the amount and specific gravity of the urine secreted, that the power of the other kidney is not impaired, this operation may be performed, if the fistula persists and gives much inconvenience, or if the discharge of pus is at all considerable. With only one kidney active, there is naturally greater risk if there is any amyloid change.

It must always be recollected that, particularly in the case of adults, nephrolithotomy can only be looked upon as giving temporary relief. The tendency to the formation of calculi is there still, and the same precautions as to diet, &c., must be taken after the calculus has been removed, for fear of recurrence.

NEPHRECTOMY

Excision of the kidney may be required for persistent hæmorrhage following injury; suppurative pyelitis (whether calculous or tubercular) in which the renal tissue is hopelessly destroyed and the disease limited to one side; sarcoma or carcinoma; and, as a sequel to nephrotomy when (the other kidney being sound) a fistulous channel is left.

It may be performed either through the loin or the abdomen.

1. *Lumbar nephrectomy.*—Morris recommends an oblique incision parallel to the last rib, with, if more space is required for dealing with the pedicle, a vertical one running down from it, just in front of its posterior extremity. The further steps of the operation are the same as in nephrolithotomy until the surface is exposed. As soon as this is reached, it must be freed from the tissues around. In some cases there are no adhesions; in others they are so dense that it is impossible to divide them without using scissors. Occasionally it is better to open the capsule, and try to shell the kidney out from it.

The next step is to secure the pedicle. It may be possible to draw the kidney so far out that the ureter can be isolated and a ligature passed round the vessels with ease. (Greig Smith recommends that, if this is done, all traction should be taken off before the knot is tied, for fear of the artery slipping back). In other cases there is the greatest difficulty, and the mass must be secured with a clamp, or with an écraseur, and cut away piecemeal before the deeper structures are sufficiently exposed. The artery and vein may be tied in one (if an abnormal branch is detected it should be dealt with by itself), and as soon as the surgeon has satisfied himself that the ligature is safe, the kidney-tissue or the pelvis divided at a sufficient distance and the rest of the mass removed. The ureter should be brought out at the lower angle of the wound, and fixed by a suture to the skin. In some cases the ligature has been placed almost on the side of the vena cava, but where it is possible a sufficient length of vessel should be left between. Finally the wound must be thoroughly dried, the peritoneum examined to see that it has not been rent, and a large drainage-tube inserted.

2. *Abdominal nephrectomy.*—The incision is made through the corresponding linea semilunaris (after Langenbeck's method), and the peritoneal cavity opened sufficiently to introduce the hand. The intestines are held on one side with sponges, and the condition of the opposite kidney ascertained as far as possible.

The posterior layer of parietal peritoneum must be divided on the outer side of the colon (so as to avoid injuring its vessels) and the surface of the kidney exposed and freed from its surroundings. As soon as everything is clear (the assistant holding up the torn edges of the peritoneum, and at the same time depressing the margins of the abdominal wound) the vessels are isolated and a ligature (double if possible) passed round them and tied. The separation is then completed and the mass removed.

The cut edges of the ureter may be inverted and stitched over, so that the stump can be left secure; or, if it is full of putrid pus or tubercular material, it may be pushed out through an opening in the loin and fastened to the skin. The plan of securing it in the anterior wound is objectionable, as tending to disturb the relation of the peritoneum.

The cavity left behind the peritoneum must be thoroughly cleansed, the flaps that have been detached pressed back into it (they need not be fastened with any stitches), and then the abdominal wound dealt with.

The relative merits of these operations are very differently appreciated. There is no doubt that in the case of very large masses the abdominal operation is the easier of the two (although, if it is cystic, the size may be considerably reduced by tapping); that the pedicle is more accessible, and that a certain (very small) amount of information about the condition of the other kidney may be obtained. Further, if the nature of the tumour is doubtful, there is very much greater liberty of action. On the other hand, the peritoneal cavity is always opened; the colon is endangered; the ureter is difficult to deal with; if the operation is performed for suppurative or tubercular pyelitis, there is considerable danger of infecting the peritoneum, and drainage is almost out of the question.

SURGICAL ASPECT OF THE URINE

Examination of the urine is essential, not only for diagnosis in diseases of the urinary organs, but to obtain some idea concerning the activity of the metabolism of the body and the secreting power of the kidneys. Except in emergency, no operation should be performed without this having been considered; it influences the prognosis more than anything else, especially when the urinary tract itself is concerned.

1. QUANTITY

The amount passed during twenty-four hours must be ascertained in order to form an idea as to the reaction and the proportion of solids. It is sufficient in most cases to take the last two figures of the specific gravity, and double them, or, if the urine is concentrated, multiply them by 2·33. This gives roughly, in grammes, the total solids for 1000 c.c. of urine, and if it is collected for twenty-four hours the rest is easy. Important constituents must be estimated separately.

When a patient is confined to bed the amount of urine (as regards both solids and liquid) is always diminished, so long as there is no fever.

The quantity may be lessened by general causes, such as fevers, profuse sweating, diarrhœa, &c.; or from local ones affecting the circulation of the kidney, or its secreting power, or both together. Acute nephritis, for example; congestion from cardiac disease; vasomotor disturbance excited reflexly by irritation of the urethra, especially if the kidneys are diseased already; interstitial nephritis and amyloid and fatty degeneration in their later stages; hysteria even occasionally; and shock, as after railway accidents, are all attended by diminished secretion. Sometimes the difference is only slight; in the worst cases there is complete suppression; no urine is passed for days. When one ureter is blocked there is rarely much difference in the quantity, even at the first, owing to the increased activity of the remaining kidney; but when both are affected, as when there is an insurmountable obstacle to the exit of the urine, suppression must occur.

In diabetes there is a great increase both in the amount of solids and of liquid; in hysteria and simple polyuria, due to lesions of the nervous system, only the latter. In contracted granular kidney, cystic degeneration, and the early stages of amyloid disease, there may be a noticeable increase in the amount, but at the same time the specific gravity is diminished so that the total solids may fall far below the normal. In the matter of prognosis this is scarcely less important than the presence of albumen; the drain upon the strength may be less severe, the loss of colour and of condition be less marked, than when there is a constant daily waste of nitrogen; but the elimination of effete products is often very much more defective.

2. COLOUR

This depends partly upon concentration, partly upon the addition of foreign substances, such as blood, bile, melanin, and, under certain conditions, indican. Carbolic acid, when present in the blood in excess, gives the urine a peculiar dark-green smoky tint, which, if it is allowed to stand for some time, may become almost black.

3. ODOUR

In chronic cystitis the urine is often offensive, even fæcal; or it may be ammoniacal from decomposition. Characteristic odours are produced by turpentine and other drugs.

4. Reaction

Normal urine is acid, and this becomes more marked during the first few hours, if it is allowed to stand in a clean vessel. Concentration, an excessive amount of nitrogenous food, and diminution in the quantity of alkaline phosphates, a condition frequently found in ill-nourished strumous children, increase the acidity. Associated with this is a peculiar train of symptoms, such as are common in gouty patients: the bladder is irritable, there are frequent attacks of dyspepsia, neuralgia, cramp, and palpitation; irritability of the skin is not uncommon; sometimes eczema and psoriasis occur; gravel is present from time to time, and slight attacks of synovitis are of frequent occurrence.

On the other hand, urine may be neutral or alkaline, from the presence of fixed alkali or of ammonia.

(*a*) If there is fixed alkali, the blue colour of litmus paper is permanent. This may occur temporarily at certain hours of the day, depending upon the meals, without any special significance; but when it is permanent, it usually points to some serious interference with the metabolism of the body. It has been noted as a precursor in affections of the nervous system, and in the early stages of cancer.

(*b*) Carbonate of ammonia is always due to a micrococcus growing in the urine; and the mucus assists it by rendering the urine less acid, or even alkaline.

Solid Constituents

(*a*) *Normal*

Urea.—The amount depends, to a certain extent, upon the age and the activity of the individual. According to Ralfe, the average for each pound of the body weight, if between 40 lbs. and 60 lbs., is 4½ grains; between 60 and 120, 4 grains; between 120 and 160, 3½ grains; and between 160 and 175 lbs., only 3¼ grains.

For clinical purposes the urea may be estimated with sufficient accuracy by the sodium hypobromite method, although the whole amount is not obtained by about 8 per cent.

It increases in fever, after excess of nitrogenous food, and in diabetes. Diminution may be dependent upon diminished formation, as in diseases of the liver, especially acute yellow atrophy and extensive carcinoma; or upon diminished excretion. The latter points to failing kidneys, and is a very serious element in prognosis for all operations, but especially for those involving the urinary tract.

Uric acid either occurs as such, forming a brick-red sandy deposit, or united with the alkalies or alkaline earths as a salt. Then it appears as a pink precipitate, rarely crystalline, which gradually settles down on the sides of the vessel as the urine cools. Neutral sodium urate is the most abundant in normal urine; the acid salt, with small quantities of the corresponding calcium one, occurs in urinary calculi and gouty deposits. Acid ammonium urate is only found after decomposition of the urea. Potassium and lithium urates are more soluble. The amount depends partly upon the supply of nitrogenous food, partly upon excessive tissue-waste and diminished oxidation. In gout, chronic diseases of the liver, and general malassimilation, it increases considerably, and is deposited wherever the circulation is feeble.

Whether it occurs in solution or as a sediment depends upon the concentration and reaction. The crystals may be recognised by their colour (in the urine), by their whetstone shape, or by their being aggregated into rhombic bundles. Urates are generally amorphous, but sometimes they crystallise as rhombic needles, arranged in a stellate manner.

Oxalate of lime is met with as a deposit in neutral, acid, and faintly alkaline urine. The crystals are either octohedral (envelope crystals) or dumbbell-shaped. In many instances it is only accidental, caused by the presence of oxalate of lime in the food (in rhubarb, tomatoes, onions, &c.), or by malassimilation; and then it is usually found some hours after meals. In those, however, who are harassed, careworn, over-worked, and hypochondriacal, it may be constant, and give rise to various anomalous nervous symptoms, such as frequency of micturition, pains across the loins, a sense of tightness round the chest, &c.

Oxalate of lime is closely associated with the decomposition of mucus. It is found not merely in that which is secreted by the urinary passages, but in that from the uterus, gall-bladder, vesiculæ seminales and prostate, sometimes in the form of crystals. The importance of this in the causation of calculi can hardly be over-estimated.

Phosphates.—Acid sodium and potassium phosphate are never precipitated; phosphates of lime and magnesia are thrown down when the urine is alkaline, or sometimes if it is boiled. This may occur even when the urine is slightly acid, if the reaction is due to the presence of an acid salt.

Phosphate of lime is usually amorphous, but it may form stellar crystals, similar in some respects to those of uric acid. Acetic acid, however, dissolves them at once. Magnesium phosphate is deposited with it under the same conditions. If the urine is alkaline from the presence of bicarbonates, they may be precipitated without being in excess; but under some circumstances, particularly in that state which is not seldom the precursor of diabetes and cancer, the alkaline and the earthy phosphates are both excessive. If they are deposited in the bladder, they often cause a certain amount of irritation by collecting towards the end of micturition and coming away in a thick creamy mass, which leaves a white crust as it dries. Fortunately they rarely form calculi.

When the urine is alkaline from ammonia, the triple phosphate of ammonia and magnesia is thrown down in triangular prisms (coffin-lid crystals) which form masses entangled in mucus. This is the crust that develops upon calculi, foreign bodies introduced into the bladder, and even upon the surface of ulcers in the pelvis of the kidney and bladder, as soon as the urine decomposes.

(*b*) *Abnormal*

Cystin is an occasional cause of calculus. It may be recognised by its being thrown down from an alkaline solution on the addition of acetic acid. The crystals are colourless six-sided plates, and are readily soluble in ammonia. Its pathological significance is unknown; from the large quantity of sulphur that it contains Ralfe is disposed to connect it with taurin. I have met with two families in which it was present; several of the members of more than one generation were affected, but no calculi were formed; and they did not appear to be in any way inconvenienced. The sulphur may be recognised by the black precipitate obtained by boiling the cystin in liquor potassæ, and adding acetate of lead.

Xanthin is still more rare. It has been met with as gravel, especially in youths; and a few calculi are recorded. It is readily soluble in dilute hydrochloric acid, from which it may be obtained on evaporation in the form of hexagonal crystals. Like cystin, it does not give the murexide reaction, but if evaporated with nitric acid a red colour is formed on the addition of liquor potassæ.

Albumin.—The ordinary forms are serum albumin and serum globulin; egg albumin may occur in cases of excessive consumption; hemi-albumose has been noted in mollities ossium; and peptones have been found in acute septic diseases, but they are hardly of surgical importance.

Its presence may be ascertained by boiling, a few drops of acetic acid being added if the urine is alkaline; by nitric acid, carefully pouring it down the side of the tube so that the urine floats at the top; picric acid; or acetic acid and ferrocyanide of potassium. If urates are present they must be dissolved by warming, or filtered off; phosphates, which are precipitated by boiling under certain conditions, are soluble in nitric acid. The total amount passed within a certain time can be estimated by precipitation with heat, or picric acid, and allowing it to settle in a graduated tube; but the method is very rough, even when the sample tried is taken from the day's collection.

Excluding functional albuminuria (which may arise from derangements of digestion or of the nervous system, or from altered conditions of the blood), the albumin may come either from the kidneys or from some other part of the genito-urinary organs. In the former case it may be caused by inflammation (as in all the forms of nephritis); congestion, as in cardiac disease; lardaceous or fatty degeneration; or the presence of new growths. In the latter it is derived mainly from the secretion of the mucous membrane. The diagnosis as to locality must be made, either from the constitutional symptoms that are present, or from other features of the urine, such as alteration in specific gravity, the presence of casts, blood, epithelial cells, &c. It must not be forgotten that the two not unfrequently coincide.

Renal albuminuria is of importance for two chief reasons.

In the first place the daily waste of so much nitrogenous material represents a continual loss of strength and diminished power of repair. In the second, it points to a morbid state of the kidneys, in which they are scarcely able to do their work, even under ordinary conditions. The effect, when after some operation or injury an immense extra strain is thrown upon them, can be imagined: the albumin increases; the excretion of urea and other waste becomes more difficult; wounds heal less rapidly; and there is a much greater liability to inflammatory complications. The effect is the same in contracted granular kidney, when ordinarily there is no albuminuria, but only urine of low specific gravity and abundant quantity.

In operations on the deeper portions of the urethra, in patients suffering from albuminuria, there is a still further reason for anxiety. In all such there is a great liability to acute renal congestion, probably caused by the vaso-motor nerves. Even when the kidneys are healthy, the secretion may sustain a sudden check, and albumin and even blood appear in the urine; if they are inflamed or seriously degenerated, the secretion may stop altogether, and the operation be followed by the worst and most fatal form of urethral fever.

In all operations of expediency, therefore, the presence of albumin in the urine (and the specific gravity, if it is persistently low) must be carefully considered side by side with the physical condition of the patient, before anything is settled. Unhappily, when the urinary tract is involved, the operation is usually one of necessity rather than expediency, and the disease itself not unfrequently the cause.

Albuminuria due to amyloid degeneration of the kidneys is in some respects an exception. Even when it is constantly present, so long as the amount is small, complete recovery may follow the removal of the exciting cause.

Albumin derived from other portions of the urinary tract, whether from the pelvis of the kidney, the bladder, urethra, or vagina, is due to the addition of mucus, blood, or pus; very rarely from the admixture of spermatic fluid. Except in the case of pyelitis, the amount is always small, and the chief importance is in the diagnosis.

Blood.—In the strict sense of the term hæmaturia should not include hæmorrhage from the walls of the urinary passages, following or preceding micturition; but, for the sake of convenience, they are always considered together, and the blood may come either from the kidney, bladder, or urethra.

The colour depends partly upon the amount, partly upon the time it has been mixed with the urine. If the hæmorrhage is recent and profuse, as in a villous tumour of the bladder, or rupture of the kidney, the colour is simply that of unaltered blood; when it is poured out slowly in the tubules, or allowed to collect in the bladder, it gradually becomes more dusky, until the tint is a characteristic smoky brown.

Tests.—The presence of blood in the urine may be recognised:

(1) *By the colour*, red or smoky, as the case may be. Carbolic acid gives urine a brownish hue, and certain drugs (such as senna and rhubarb) and articles of diet (beetroot, sorrel, &c.) in quantity turn it red, but they can easily be distinguished. In hæmoglobinuria the colour is, of course, identical.

(2) *By the spectroscope.* There is a broad dark band between D and E, which on dilution gradually separates into two. Sometimes there is a band between C and D, nearer the former (acid hæmatin); or midway between the two (methæmoglobin).

(3) *By the microscope.* Blood-corpuscles retain their appearance for some time in acid urine; when it is alkaline, the colouring matter soon dissolves out. In hæmoglobinuria they are absent. Hæmin crystals may be obtained in the ordinary way.

(4) *By chemical reaction.* A drachm of tincture of guiacum is placed in a test-tube; a drop of the urine added; and then some ethereal solution of peroxide of hydrogen floated upon the top. A blue ring develops at the junction if blood is present, but the same effect is produced by many other substances.

The *source* may be conjectured from the colour, reaction, the presence of clots or of casts, the uniformity of the mixture, and the presence of other symptoms, such as renal colic, suprapubic pain, &c.

(*a*) *Renal hæmaturia.*—The blood may be bright red, but usually it is smoky and it is always uniformly diffused. The reaction is acid, unless the quantity is very large or there is a profuse secretion of pus; tube-casts may be present (they are of themselves distinctive); a long worm-like coagulum may come down from the ureter; and the attack may be accompanied by severe pain in the loins, renal colic, or retraction of the testicle. Blood-corpuscles often cannot be detected.

(*b*) *Vesical hæmaturia.*—The colour is usually bright red, unless the urine has been retained some time in the bladder, and the mixture is rarely uniform; the last drops, as a rule, contain most, whether the hæmorrhage is still going on, or whether it has ceased and the sediment has gravitated to the bottom. The reaction may be acid or alkaline; irregular shapeless clots may be present (they are best seen floated out in water), but too much reliance must not be placed upon this, for the blood may have poured down from the kidney and coagulated in the bladder.

(*c*) *Urethral hæmorrhage* is always bright red, the blood either preceding or following the urine.

Causes.—Hæmaturia is due either to a morbid condition of the blood (purpura, scurvy, &c.) or to local affections; and these may be due to injury, inflammation, or new growths.

(*a*) *Renal hæmaturia.*—Blows upon the loins and renal calculus; all forms of nephritis (even granular kidney) and hyperæmia, whether active or passive; carcinoma, sarcoma, and tubercle.

(*b*) *Vesical hæmaturia.*—Wounds (*e.g.* rupture of the bladder) and contusions caused by calculi, catheters, &c.; cystitis in all its forms, and ulceration of the mucous membrane; carcinoma, villous tumours, and tubercle.

(*c*) *Urethral hæmorrhage.*—Injury, such as impacted calculus or the passage of a catheter; inflammation, as in gonorrhœa; or new growths, such as tubercle.

Treatment.—Perfect rest and opium (unless there is nephritis or renal congestion) are the most important. Cold may be applied by Leiter's coils to the loins, the suprapubic region, or the penis and perinæum, according to the seat of hæmorrhage. Vesical hæmaturia may be checked by washing out the bladder with water of the temperature of 120° F., or, if the points can be seen, by touching them with a styptic. In urethral bleeding, a catheter may be passed, and the penis gently compressed around it with a bandage; or, if it is in the region of the bulb, Otis's crutch may be employed. Tincture of hamamelis is said to check vesical hæmorrhage when injected into the bladder. Infusion of matico has been used in the same way.

Gallic and sulphuric acids, acetate of lead, and ergot, may be given internally, but if the hæmorrhage comes from a vessel of any size they are of little service.

Coagula occasionally give rise to severe pain, and, if the urine is septic and the bladder atonic, may require speedy removal for fear of decomposition and septic absorption. This may be done most easily by means of a soft catheter and a lithotrity evacuator, the clots gradually being broken up and sucked away.

Sugar.—Glucose is probably always present in the urine in minute quantities, and in certain circumstances the amount increases without very special significance. Thus it may occur from excessive consumption; chronic congestion of the liver; prolonged narcosis; or the inhalation of amyl nitrite; or it may be present for a time, without any cause being discovered, in members of diabetic families; but though this is always to be noted in a history, it is not of the same importance as persistent diabetes.

Temporary glycosuria is not uncommon after injuries of the head, concussion of the spine, fractures of the vertebræ, and injuries to the abdomen and kidneys. Sometimes, but much more rarely, when caused in this way it is permanent.

Many of the skin affections in diabetes are due to physical causes, such as the harsh dry condition, merging into pruritus, and the eczema which is so common about the genital organs in women. Others, however, are due to the malnutrition of the tissues. Boils and carbuncles, for example, are of frequent occurrence, and the latter, in particular, are of very grave import; cataract may occur in one eye or both; amblyopia, sometimes varying according to the state of health, is not unfrequent; and what is more serious than all, gangrene, especially of the exposed parts, may be caused by the least injury. It resembles in general character the ordinary senile form, but it is usually moist and much more rapid. For fear of this, from the susceptibility to shock, and the tendency to hæmorrhage, operations, unless absolutely essential, are rarely undertaken in diabetic patients.

Chyle and lymph are occasionally found, coming from varicose lacteals or lymphatics, in the wall of the bladder. In the case of the former the urine is white, like milk; when the latter is present it remains clear; usually it coagulates, forming a loose soft clot, which gradually becomes liquid again. Chyluria is of especial interest from its connection with the filaria sanguinis hominum.

Fat.—After extensive fractures a delicate pellicle is often found floating on the surface of the urine; and the same thing has been known to occur in diabetes. Occasionally smaller quantities, with cholesterin, &c., find their way in from the breaking down of caseous masses.

Mucus.—A slight amount is always present; and, especially in women, it often forms a light, transparent, floating cloud, without having any pathological significance. In catarrh it increases very greatly, and is mixed with young epithelial cells detached from the walls.

Pus may come either from an abscess bursting into one of the urinary passages, or from the mucous surfaces, after prolonged irritation. If the urine is acid, it forms a thick creamy layer; as the reaction becomes alkaline, it collects into dense stringy masses; and if liquor potassæ is added, it forms a viscid gelatinous deposit, like white of egg. The corpuscles, as a rule, have more than one nucleus, but, unless the quantity is excessive, it is difficult to distinguish from mucus. If both are present, the best plan, as suggested by Ralfe, is to throw down the pyin with mercuric chloride, filter it off, and then add acetic acid to the filtrate to precipitate the mucin.

Pus may come from any part of the urinary system, and in general the diagnosis as to locality can only be made from other symptoms. If it is abundant, and the urine remains acid, it is probably derived from the pelvis of the kidney; when it is ammoniacal, and contains crystals of triple phosphate, some of it, at least, comes from the bladder.

URINARY DEPOSITS

Some are derived from the urine; others from the walls of the urinary passages: others again are living organisms.

1. *Deposits from the Urine*

(*a*) *From acid urine*: oxalate of lime; uric acid; urates; cystin and tyrosin.

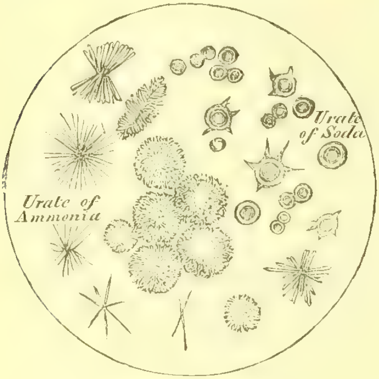


Fig. 399.—Urates.

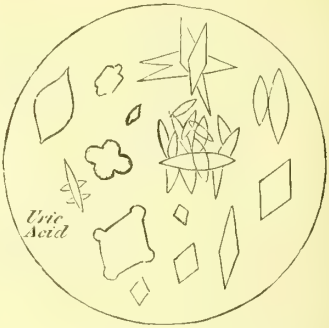


Fig. 400.—Uric Acid.

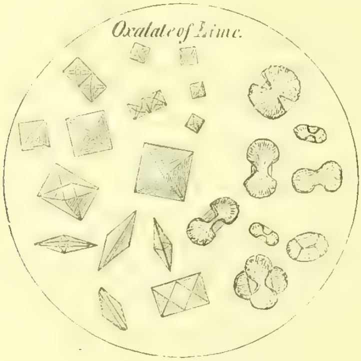
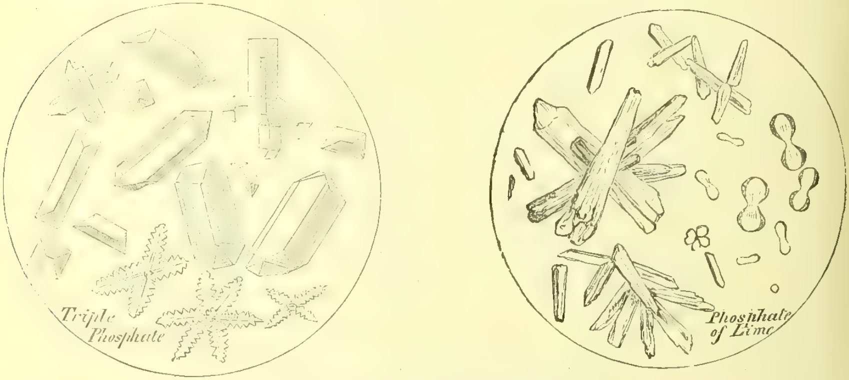


Fig. 401.—Oxalate of lime.

(*b*) *From alkaline urine*: oxalate of lime: phosphates of lime and magnesia; ammonio-magnesian phosphate; acid urate of ammonium and carbonate of lime.



Figs. 402 and 403.—Phosphates.

2. *Deposits from the Walls of the Urinary Passages*

(*a*) *Epithelium* coming from the kidney; from the pelvis and ureter; from the bladder; or from the urethra or vagina. The nucleus is usually visible under the microscope, without the addition of any reagent, which is not the case with either pus or mucus corpuscles. Epithelial cells from the kidney are usually either rounded in shape or cubical; those from the pelvis and ureter more columnar, but often they are triangular or caudate; bladder epithelium, as a rule, is flatter; and that from the vagina squamous; but, with the exception perhaps of the last, it is rarely possible to be certain as to the source, unless the cells are aggregated together into masses—unless, that is to say, tube-casts are present from the kidney, or glandular casts from the prostatic follicles, or irregularly-shaped collections from the walls of the bladder.

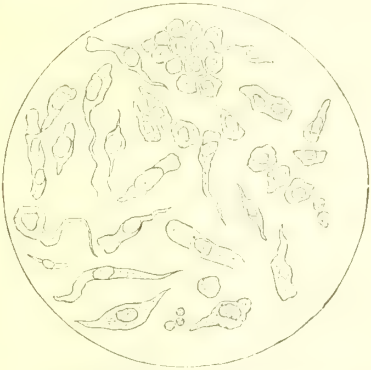


FIG. 404.—Epithelium from urinary passages.

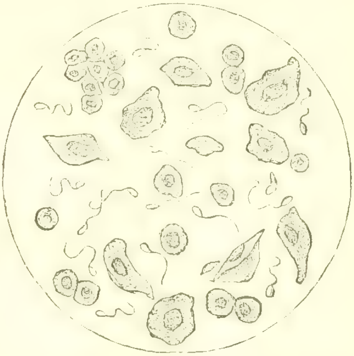


FIG. 405.—Spermatozoa and vaginal epithelium.

(*b*) *Blood*, sometimes separate corpuscles; sometimes casts or clots.

(*c*) *Pus.*

(*d*) *Mucus.*

(*e*) *Spermatozoa.*

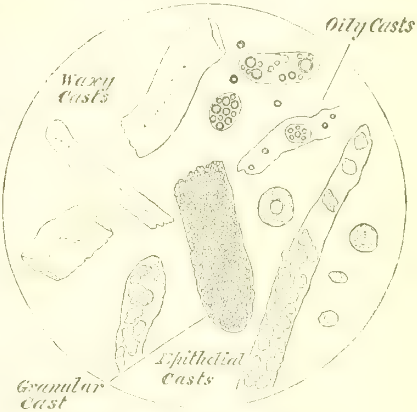


FIG. 406.—Urinary casts.

(*f*) *Fragments of new growths*, either villi or broken-down epithelial masses, and sometimes cell-nests from epitheliomata.

3. *Living Organisms*

(*a*) *Animal parasites.*—The ova of Bilharzia hæmatobia—a trematode worm—are the most common; but filaria are occasionally found, and hooklets from broken-down hydatid cysts.

(*b*) *Vegetable organisms.*—Penicillium and torulæ are found growing in urine that has been allowed to stand, the latter only when there is sugar. The bacterium of ordinary putrefaction, and the micrococcus ureæ, are of common occurrence. Tubercle bacilli may be found and recognised by proper staining, when caseous masses are breaking down and ulcerating.

In addition to these, other substances occasionally find their way into the urine, either from ulceration opening up a passage between the alimentary canal and the urinary tract, or from accidental discharges from the rectum or vagina.

CHAPTER XXI

INJURIES AND DISEASES OF THE BLADDER

ECTOPIA VESICÆ

DEFECTIVE development of the anterior wall of the abdomen and front of the bladder from the umbilicus down to the penis, involving the pubic symphysis. It is more common in males than in females, and is due to the deficient growth of the mesoblast in the embryo. At birth there is a thin membrane covering in the opening, but this soon dries up and is cast off, leaving a few shreds around the margin. It is known as extroversion of the bladder, from the way in which the posterior wall with the orifices of the ureters, being entirely unsupported in front, is pushed forwards like a hernia by the pressure of the viscera behind.

The appearance is characteristic at the first glance. In the pubic region, where the symphysis should be, there is a round, red, vascular projection of mucous membrane, which becomes more prominent whenever the child cries or strains. On the front of this are the ureters, with drops of urine falling from them at regular intervals. Above is the linea alba, generally very much widened, so that the two recti are far apart; below is the flattened penis, with on its surface the urethral groove and the openings of the prostatic follicles; and on each side is a rounded projection, caused by the pubic bones, which do not meet in the middle line. The testes may be present in the scrotum, or they may still be in the inguinal canal; and there may be a hernia as well on either side. The thighs are widely separated from each other, so that the gait is waddling, and if the skeleton is examined the obturator foramina are smaller than natural, the iliac bones straighter, and the pubic ones separated by an interval of from two to four inches.

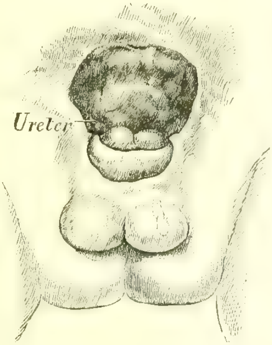


FIG. 407.—Ectopia vesicæ in the male.

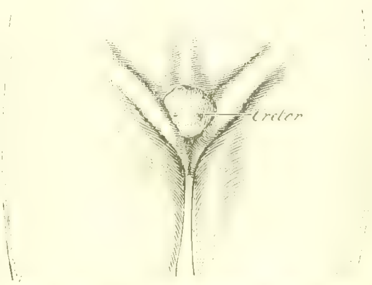


FIG. 408.—Ectopia vesicæ in the female.

In the female the appearances are so much the same that sometimes there is a little difficulty in determining the sex. The testes, however, or the body of the uterus, as the case may be, can usually be made out without much difficulty.

In older cases the skin around becomes sodden and excoriated; the surface of the projection becomes rough and granular from the constant friction and irritation to which it is subjected; papillary growths spring up around the ureters, so as to cause a slight degree of obstruction; this leads to dilatation, and at length the pelves of the kidneys become involved, the secreting substance is absorbed, and interstitial nephritis sets in. Suppurative inflammation, however, is rare, owing to the very free drain that exists for the urine. Sometimes, when the ureters are dilated, the urine is ejected in small jets when any pressure is made upon the abdomen.

Treatment.—Many attempts have been made by reflecting flaps of skin to cover in the opening and form an anterior wall for the bladder; of these the most successful is Wood's, but even with this the greatest benefit that can be hoped for is the formation of a cavity which will retain urine for a short time with the aid of an appliance. In general, all that is possible is to cover in and protect the surface, leaving at the lower part an orifice through which the urine can drain into a urinal.

Some time beforehand the hair-follicles must be destroyed by epilation and nitric acid; if left, phosphatic concretions are liable to form upon the hairs and become the source of much annoyance. The flaps are arranged so that there is a double layer in front, one with its epidermis facing the bladder, the other laid over this, raw surface to raw surface, facing the other way. The former of these, if the opening is of any size, is reflected down from the abdominal wall above the umbilicus, giving it as wide a pedicle as possible, and making it sufficiently large to reach the soft tissues on either side, and come well down on to the root of the penis. Care must be taken in doing this that the abdominal cavity is not opened, for the aponeurosis beneath is very much stretched and thinned. The flaps to cover this in are taken from either side, the root of each being formed by the side of the scrotum and the urethral groove; and they should be large enough when brought together and united in the middle line to cover in the whole of the vesical flap, and reach well on to the raw surface above it and at its sides.

In dissecting up these the greatest care must be taken not to bruise the edges, or score with the knife the under surface of the skin. Hæmorrhage should be checked at once by torsion. The vesical flap is laid in position first, being turned down on itself so that the epidermic surface faces the bladder. The apex is secured by two stout wire sutures, one on either side, to the margins of the urethral groove, close to the roots of the lateral ones; and the edges, if necessary, to the margins of the raw surface at the sides with catgut. Meanwhile, its surface, as well as that of the lateral flaps, is gradually becoming glazed over. When all oozing has ceased, a stream of some warm antiseptic is gently poured over to wash away any clot, and when they are thoroughly clean and dry the two side flaps are brought over the vesical one, pressed down firmly upon it by means of a sponge, and secured to each other and to the margins with wire. This covers in the whole of the bladder, leaving at its lower end an opening on the dorsum of the penis tightly embraced by the roots of the side flaps. The edges of the wounds from which the vesical flaps have been reflected should be brought together as far as possible by means of harelip-pins; the rest may be left to granulate up, broad bands of strapping being fastened over the dressings to support the whole.

After the operation the patient must be kept absolutely quiet, in a sitting position, with the knees well supported and secured by bandages, so that there is no strain upon the sutures; and as this becomes very irksome, it may be necessary to keep him under the influence of some narcotic. If all goes well, the sutures may be removed at about the end of the week. Very often there is some yielding at the upper angles, especially if the flaps are rather short, and this may give rise to troublesome fistulæ. Even in the most successful cases the orifice usually enlarges, owing to the pressure on the tissues behind it, and at length requires to be covered in by some operation similar to that practised for epispadias.

When the opening is not so large, Wood recommends that two lateral flaps only should be used, each having a pedicle springing from the scrotum and the side of the urethral groove. The size, of course, varies with the case, but they must be each of them sufficiently large to cover in the whole of the bladder. The same precautions are required as in the previous case. When the surfaces are glazed one is twisted round and laid with its epidermis towards the cavity, and the other is laid upon this and secured to it and to the margins.

Thiersch's method is simpler, and succeeds better, as some of the cases acquire a certain degree of control. A new urethra is formed first. In the region of the glans a deep groove is cut on either side of the mucous membrane, and the edges are brought over and united by twisted sutures. Behind, in the penile part, a new roof is formed from reflected flaps of skin. One of these is taken from each side, and they are so arranged that while the first is reflected towards the groove (so that, when it is in position, the epidermic surface faces the mucous one), the second, which should be considerably larger, is slid over the raw surface of the other.

As soon as this is accomplished, and the parts are fairly firm, the front of the bladder is closed in. Two longitudinal flaps of skin are dissected up, one from each side, of sufficient length and breadth combined, to cover the exposed mucous membrane. Each is separated at the sides and beneath, but left attached at the ends, so that the under surface may cover itself with granulations. At the end of a fortnight or three weeks, when they are thick and vascular, the upper end of the lower one is divided, so that it can be twisted on its lower attachment (which lies close by the root of the penis), and placed across the lowest part of the bladder, just above the new urethra (a groove is cut in the opposite side, by the border of the mucous membrane, to receive its upper end). Then, a short time later, the other one, which lies on a slightly higher level, is divided in the same manner, and carried over the upper half. By means of these two flaps, the greater portion of the cavity is covered in; the little angle above is patched up from the front of the abdomen; and the similar one below by means of a loop from the scrotum.

More recently, Trendelenburg has advocated the division of the sacro-iliac synchondrosis from behind, and the gradual approximation of the pubic bones, by properly contrived splints, until the sides of the cleft are sufficiently close o be united. The operation is performed during infancy. The left foreinger is kept in the rectum to ascertain the position of the sciatic notch, and avoid the gluteal artery. An incision from two to three inches in length is made through the soft structures on the back of the joint, from the posterior uperior spine downwards; the posterior ligaments are divided, and then the interosseous ones, until the joint can be forced open by lateral pressure, and the pubic bones brought together. The wounds behind are dressed and drained; and the child is placed in a V-shaped splint, well padded, to protect the bony prominences, until the healing is complete. Afterwards, the edges of the cleft are deeply pared and brought together. Unless the pubic bones can be placed in apposition and sutured together, the operation cannot be considered successful; later, the cavity of the bladder must be dilated by continuous pressure with a rubber bag, and the urethra completed.

The same thing has been attempted by gradual pressure without division of the ligaments, the prominences being protected by means of rubber rings and the points varied as much as possible.

Injuries of the Bladder

The bladder may be injured by stabs or gunshot wounds, through the abdominal wall, the rectum, or the vagina; it has been punctured through the sacrosciatic foramen; it may be torn by one of the pubic bones in fracture of the pelvis, or wrenched from the triangular ligament by separation of the symphysis; it may be bruised to such an extent in parturition, or by the presence of the retroverted uterus, that the wall sloughs and gives way; and when it is distended it may be ruptured by compression. If the tissues are healthy, the force necessary to effect this must be considerable; if, on the other hand, they are diseased in any way, it may be altogether insignificant: even muscular action is enough.

Rupture of the bladder, therefore, is said to be either traumatic or idiopathic. In the former, the walls are sound, the force severe, and the rent in general runs along the posterior surface, vertically down from the urachus, for one or two inches. In the latter it takes the form of a ragged opening with thinned and sloughing edges; and the locality depends upon pre-existing conditions. There may, for example, be a pouch protruding from between the muscular fasciculi, formed only of mucous membrane and cellular tissue, and ready to give way with the least pressure; or an ulcer caused by the pressure of a catheter, or by syphilis, tubercle, or carcinoma. In other cases a calculus has been known to cause gradual thinning at one spot, until the wall broke down almost of itself; and in others, again, the tissues are so weakened from long-continued distension and fatty degeneration as to yield simply from the weight of the contents.

The most frequent cause is a blow upon the lower part of the abdomen, but it may be produced by contraction of the abdominal muscles, as in lifting heavy weights; and perhaps, for the same reason, by violence applied to the back. In one or two instances, in which it has been due to a fall in the sitting position, it was probably the result of the sudden impact of the fluid against the base. The bladder must be distended, or it cannot be torn (though it may be punctured); and, partly for this reason, partly because in alcoholism the protecting influence of the muscles is in abeyance, it is peculiarly likely to occur in men when they are drunk.

The rupture may be either intra-peritoneal or extra-peritoneal. Occasionally it extends through the reflection of the peritoneum; and a few instances are recorded in which the rent has been really subperitoneal, involving only part of the thickness. The character of the opening depends upon the condition of the wall: if this is healthy, it resembles a lacerated wound, and the blood pours out freely into the peritoneal cavity, or behind the pubes; when the rupture is due to ulceration, the opening is usually round or irregular, with everted and perhaps sloughing edges, and the bleeding is slight.

Symptoms.—The typical symptoms are a feeling of something giving way; collapse; severe pain; inability to stand upright or walk; and desire, but want of power, to micturate. Not one of these, however, is always present, and the only evidence that can be relied upon is that obtained by passing a catheter; the bladder either contains only blood or a small quantity of blood-stained urine. Collapse may be wanting: patients have walked to hospital, twenty-four hours after the accident, simply from anxiety at not having passed any urine. Inability to micturate cannot be relied upon, for partial and even complete power has been retained, especially in extraperitoneal cases. Sometimes there is no pain at all; and particularly when the accident has occurred during drunkenness, so that no history can be obtained, and it is merely a matter of conjecture whether the bladder was full at the time or not, the diagnosis may be a matter of the greatest difficulty, especially during the period when treatment is most valuable.

Even the evidence given by the use of the catheter requires consideration. If it was known that the bladder was full, and if nothing but blood or a few drops of urine mixed with blood come away, there can be very little doubt; and this little may be removed by the sensation conveyed by the instrument; it is clearly not in a cavity; it cannot be rotated or depressed; the walls everywhere are in contact with it, and cling around it. The instrument, however, may slip through the rent in the wall and enter the peritoneal cavity; or there may be only a puncture, or simple leakage, such as is produced at first by the giving way of an ulcer.

Occasionally the diagnosis is difficult for the opposite reason; the bladder has been bruised, there is a certain amount of hæmorrhage, and the secretion of urine is so diminished from shock that the cavity remains almost empty for hours. It has been suggested, under these circumstances, to inject the bladder with a warm antiseptic solution, to ascertain whether it can rise well up over the pubes.

1. *Intraperitoneal rupture.*—Immediately after the accident the bladder collapses, and the urine enters the peritoneal cavity, collecting at first, at the lower part, but soon becoming diffused by the movement of the intestines. Healthy urine does not give rise to peritonitis immediately; the abdomen has been opened on several occasions, more than twenty-four hours after the extravasation, without there being any evidence of inflammation. If, however, it is left, or if the urine comes from a bladder already inflamed, as when the wall of a sacculus slough, or a cancerous ulcer gives way, peritonitis sets in within a very few hours, and becomes general, the abdomen becoming distended, the face pinched and drawn, and the pulse rapidly failing.

2. *Extraperitoneal rupture.*—In this the urine is poured out either into the loose tissue that lies in front of the neck of the bladder, or behind, between the bladder and the rectum, or the uterus. Sometimes there is a free exit, the perinæum, or the vagina, or rectum, being torn as well. If there is not, the ordinary symptoms of extravasation of urine set in, and inflammation, followed by sloughing and septic poisoning, spreads rapidly into the iliac fossæ, the front wall of the abdomen, and even into the scrotum,

through the inguinal canal. Generally, the peritoneum becomes involved as well before the patient dies.

Prognosis.—Gunshot injuries are not so fatal as might have been expected; the urine escapes through the wound, and retention and decomposition are prevented. The same occurs when the bladder is wounded by foreign bodies pushed into it through the rectum or vagina, or when it sloughs in consequence of pressure during parturition. When there is no external wound, or easy exit for the urine, it accumulates, decomposes, and acts as a virulent poison.

Treatment.—The first indication is to remove the urine that has already escaped, the second is to close the rent in the bladder so as to prevent further extravasation.

Until within the last few years there was no certain case of recovery after rupture of the bladder into the peritoneum. Various methods had been attempted: the abdomen had been opened, thoroughly cleansed, and the wound in the bladder closed; but either leakage had taken place or the sutures had given way. The peritoneal cavity had been washed out through the rent. The bladder had been drained, not only by catheters, but by median and lateral cystotomy, to prevent the exit of any more, hoping that the peritoneum would be able to deal with that already present; but all without avail. It was not until Lembert's fashion of suturing the intestines was applied to the bladder that there was any success, and then MacCormac's, Holmes's, and Walsham's cases followed rapidly one after the other. Now there is no doubt: the patient is placed under an anæsthetic; a rubber bag introduced into the rectum to raise and fix the floor of the bladder; and an incision made in the middle line, ending just below the upper border of the pubic symphysis. The extra-peritoneal portion of the bladder is examined first by gently pushing the fold of peritoneum upwards. If there is no extravasation of blood there, or evidence of bruising, the peritoneal cavity itself is laid open and the rest of the bladder carefully felt. If there is a rupture, the edges are steadied and drawn forward by hooking up the nearer end with a blunt and rounded retractor (a suture is unnecessary and only inflicts further injury), and then a series of Lembert's sutures passed close together, commencing in the sound tissue beyond either end of the rent and carefully avoiding including any of the mucous membrane. Greig Smith recommends a double row, one to transfix the cut muscular surface, the other, Lembert's, outside this; and that all should be passed before being tied. The intestines are held back out of the way, in the meantime, with a soft flat sponge. Then the abdominal cavity is cleared of all blood-clot and urine that may have found its way in, and irrigated either with warm water (temp. 100° F.), or with a dilute solution of some non-poisonous antiseptic. The wound should be closed in the usual way, introducing a drainage-tube only when there is already peritonitis. If there is any doubt as to the security of the sutures in the walls of the bladder, they can be tested first by distending the cavity through a catheter. Silk is the best material, and the sutures should not be more than one-eighth of an inch apart; catgut, even if it were so certain, is difficult to knot securely when the wound lies deep in the cavity of the pelvis. In one or two cases the difficulty has been so great that it was necessary to make a short transverse incision through the peritoneum on either side.

After the operation the bag in the rectum is emptied and withdrawn, a suppository or a hypodermic injection of morphia given, and the patient kept warm and quiet in bed, with only a small quantity of ice to suck or a few tea-spoonfuls of milk. At first there is very little urine secreted, and if the sutures are sufficiently close there is no need to pass a catheter, much less to tie one in, or perform cystotomy; the bladder is able to empty itself without risk.

Extra-peritoneal rupture must be treated on the same principles. If the rent can be secured from the front, an opening should be made over the pubes, and Lembert's sutures passed as before; only, as it is impossible to remove the urine from the loose cellular tissue around the bladder, the abdominal opening should not be closed and a large drainage-tube should be inserted. Wounds involving the rectum or vagina, if not very large, may be left for a time; very frequently they close in; or, if not, contract so that the resulting fistula is much smaller. Wounds in other parts are usually complicated by other injuries.

DISEASES OF THE BLADDER

Atony

The bladder is said to be in a state of atony when the muscular power is impaired, without there being any evidence that the nervous system is affected.

Atony may occur when the walls are healthy, but it is much more likely if the strength of the muscles is enfeebled by old age or inflammation. In such cases, even passing a catheter or drawing off residual urine may abolish the small amount of power that still remains.

Atony may be caused by a single act of retention: the bladder becomes over-distended; the muscular fibres over-stretched; and all power is lost, perhaps for life. This may happen even in voluntary cases, although it is more likely if the obstruction is mechanical. More frequently the loss of power is gradual and slowly grows worse; the bladder is imperfectly emptied; some urine always remains behind; the amount grows larger and larger; the muscular coat becomes accustomed to it; and at length the bladder remains full, the urine falling out of it, drop by drop, as it enters from the ureters (overflow).

Obstruction sometimes causes atony, sometimes hypertrophy. The difference depends, to some extent, upon the age and strength of the patient; the effect of retention is different naturally in an old man of feeble health and in a younger one of vigorous life; but the chief causes are the rapidity with which the obstruction is produced, and the amount of irritation at the neck of the bladder. In cystitis, for example, and in cases of enlarged prostate in which there is much spasm, hypertrophy usually results. When, on the other hand, the prostate is tender and painful as the bladder contracts and presses upon it, the patient, perhaps unconsciously, tries to save himself and quietly stops before he has finished. If this happens constantly, the bladder at length loses the power of emptying itself, and atony sets in. The same thing happens from purely mechanical causes in enlargement of the prostate; the bladder becomes accustomed to retain a certain amount of urine, and after a time is unable to expel it.

The immediate result of atony is distension and dilatation, owing to the pressure of the urine: the bladder grows thinner; the muscular fibres degenerate, and at length the ureters and the pelvis of the kidneys become affected. Cystitis and pyelonephritis nearly always follow, sooner or later; there is everything to favour their occurrence; and if the urea decomposes the wall of the bladder may slough.

Symptoms.—Increased frequency of micturition is the most prominent: if the bladder is over full the urine flows away without cessation; if there is less it escapes on coughing or laughing, or at night, giving rise to extreme annoyance; and the patient either complains that he is passing too much water, or that he cannot retain it. In some cases the bladder is distended nearly up to the umbilicus, forming a rounded fluctuating swelling on the front of the abdomen. In others, especially where chronic cystitis precedes the atony, the size is so small that it can scarcely be felt. The diagnosis can only be made by passing a catheter, after the patient has, as he thinks, emptied his bladder; if there is atony a variable amount flows away without any force, the stream rising and falling with the respiration. This proceeding, however, is not unattended with danger; the patient must be lying down; sudden evacuation of a bladder in a state of passive distension has before now caused fatal syncope; and if the amount of urine withdrawn is over a few ounces, some of it must be replaced by a smaller quantity of some dilute antiseptic, so that the pressure in the bladder may be gradually reduced. Too sudden relief brings on passive congestion of the renal vessels; and this, if the kidneys are in the least diseased, may end in suppression.

The **treatment** is very simple: in the first place, the cause of the retention, if it is practicable, must be removed; then the bladder must be carefully emptied, at least four times in the twenty-four hours, so that there may be no further strain upon the muscular wall. If the amount of residual urine was large it may be some weeks before it is safe to remove it completely. A catheter should not be tied in, the danger of cystitis and urinary fever is much too great. Subcutaneous injections of strychnia are sometimes of benefit, and occasionally the walls may be stimulated by injecting cold water after the bladder is emptied. Galvanism, one pole in the rectum, the other on the surface of the body, and the current slowly interrupted from time to time, may effect some improvement even in advanced cases.

IRRITABILITY OF THE BLADDER

Irritability of the bladder is a symptom, not a disease. It is present, to a greater or less extent, in all local affections, such as cystitis, calculus, tumour, fissure at the neck, atony, &c.; in cases in which the urine contains an excess of uric acid or other irritating substances; and sometimes in affections of other organs which apparently have nothing to do with the bladder. It may be only slight, giving rise to a certain amount of annoyance, or it may be so intense as to render life almost unendurable. In itself it is a matter of some importance, as the constant contraction of the bladder leads in time to hypertrophy of its walls and dilatation of the ureters and of the pelvis of the kidneys.

The most common cause is some affection of other parts of the urinary system. In many of these the neck of the bladder is involved directly. In congestion of the prostate, for example, after excessive coitus or masturbation, or in that form of slight irritation which is so frequent in gouty people of sedentary habits, and in women when the bladder is pressed upon or dragged out of its place in pregnancy, it is reasonable to refer the irritability to the congestion and increased sensibility at the neck. In other instances, however, it is probably reflex. All diseases of the kidney, for example, are liable to be attended by it; in tuberculous pyelitis, in particular, it is a most distressing symptom, as, unlike the irritation of tuberculous cystitis, it cannot be relieved by median cystotomy and drainage; and it may be caused by phimosis, with accumulation of the secretion beneath the prepuce, by slight strictures near the orifice, or by vascular growths or superficial fissures around the meatus in women. Its reflex character is still more plain when it is excited by affections of other organs, such as disease of the uterus, fissure of the rectum and anus, piles, prolapse, intestinal worms, varicocele, &c.; and this is not at all uncommon.

Reflex irritability may occur even in the strongest and most healthy; it is much more frequent, however, and more obstinate in those who are broken down by excesses or by prolonged residence in hot climates, or who, from inheritance or other causes, are especially prone to nervous disorders. In some instances, and they are often the worst, no immediate exciting cause can be found; the desire to pass water is constant, or it invariably comes on under certain particular circumstances, and the patient lives in a state of continual apprehension, until, from constantly dwelling upon it, the condition becomes permanent and almost incurable.

The prognosis and treatment in cases such as these must be guided by the cause. Where some definite source of irritation can be found and removed, the prognosis is good, especially in the early stages; after it has lasted some length of time the difficulty becomes greater, partly because of the force of habit, partly from the changes that are induced in the condition of the bladder. Where nothing can be found, the chief reliance must be placed upon careful dieting and restoring the patient's strength and confidence in himself, paying special attention to any constitutional tendency that is present.

In some cases steel sounds may be used with benefit; at first they should be only of moderate size (No. 10 or 11 English) and withdrawn at once; but as soon as the mucous membrane of the urethra has grown accustomed to them, larger and larger ones may be passed, and left in position until they are no longer grasped. In women dilatation of the urethra with the finger is sometimes attended with success. Tepid douches applied to the loins and the hypogastric region for ten or fifteen minutes, if the patient can stand it, may answer; and, even when the condition is advanced, relief may be obtained by slowly injecting the bladder through the urethra, beginning with a small quantity, two or three ounces, and gradually increasing it day by day as the patient grows more accustomed to it. When all other measures fail, median cystotomy and drainage sometimes succeed. It is probable that in some instances at least the irritability of the bladder, whatever may have been the original cause, is maintained by the contracted and hypertrophied condition of the walls, and that the prolonged rest obtained in this way allows time for a certain amount of relaxation and even wasting, so that when the artificial opening closes the bladder becomes more tolerant.

INCONTINENCE OF URINE

Nocturnal incontinence.—Closely allied to irritability is a condition, very common in children, especially boys, in which the bladder will only retain a certain amount of urine. As soon as it becomes filled to a certain point it contracts, and expels its contents, without any pain, and without the child being able to prevent it. This is known as nocturnal incontinence of children, owing to its usually occurring at night. The least stimulus is sufficient to excite it (there may be a calculus, but generally, when there is one, micturition is more frequent while the child is running about): contracted prepuce with retained secretion; polypus in the rectum; oxyurides; the pressure of the bedclothes on the penis; excess of uric acid in the urine; any slight irritant, in fact, is sufficient. The most common is the tension upon the walls, and the pressure upon the neck, as the bladder becomes full.

The real reason is the excitability of the reflex centres, which is always greater in children than in adults, even during health, and which sometimes, as at the period of teething, becomes immensely exaggerated; and it occurs more frequently during sleep, because then the influence of the cerebrum is suspended, and the spinal cord is free to act for itself. Towards puberty it nearly always disappears.

Treatment.—In most cases nocturnal incontinence may be cured by care and attention. All sources of irritation that can reasonably be suspected must of course be excluded, but unless it is exceedingly obstinate, or other symptoms are present, it is rarely advisable to explore the bladder for this only. Circumcision, however, may generally be performed with advantage. Careful attention must be paid to diet, especially if the urine deposits crystals of uric acid; the amount of liquid taken, particularly towards evening, must be restricted; the child should be taken up the last thing at night; the bed should be firm, the clothing light, and the patient made to sleep on his side, not his back. The old-fashioned plan of tying a handkerchief round the waist so that the knot comes over the vertebræ, answers exceedingly well. In addition, the back should be sponged and rubbed well night and morning, the bowels made to act regularly, and quinine and tonics given internally. If anything more is required, belladonna rarely fails; either the tincture or the extract may be given, commencing with small doses, and gradually increasing them until the drug produces some physiological effect, such as dryness of the mouth and fauces or dilatation of the pupil. The dose should then be diminished, and kept up for some weeks, leaving it off gradually. Nux vomica and cantharides are also said to be of service.

In very inveterate cases a soft bougie may be passed, or a dilute solution of nitrate of silver (gr. ij ad ℥j) applied to the neck of the bladder. Galvanism, one pole being placed in the rectum, the other over the sacral region, and the current occasionally reversed, sometimes succeeds where everything else has failed.

True incontinence in men is very rare. It is common for patients to complain that they are unable to hold their urine, or that it is constantly running away from them; but it rarely happens that this is incontinence in the proper sense of the term. Either the bladder is over-distended, as sometimes in stricture or enlarged prostate, and a drop falls out for every one that enters, leaving it as full as ever (*overflow*); or they are suffering from atony and partial retention, and the bladder is irritable, and unable, owing to the presence of residual urine, to hold much more. True incontinence has, however, been known to occur after the median operation for lithotomy, even when the calculus was not of unusual size; and it may follow belladonna-poisoning and injury or disease of the lumbar portion of the cord. The bladder loses its power altogether; it slowly shrinks and becomes smaller, merely acting as a mechanical receptacle, until its function is lost. It is also stated to have followed impaction of a calculus in the neck of the bladder, and in one or two instances to have been occasioned by a growth from the prostate of peculiar shape, projecting forwards into the orifice so as to prevent the action of the sphincter.

In women incontinence of urine is much more common, from anatomical reasons. Sometimes it comes on gradually in old age, the sphincter losing its power, until urine is expelled with every cough; and it may follow dilatation of the urethra for the extraction of calculi (it has been known to happen even when only the finger was used); but the most common cause is some injury to the urethra, either from the prolonged pressure of the child's head in parturition or the use of instruments. If the condition is incurable, the patient must be fitted with a suitable form of urinal.

RETENTION

Retention of urine is either partial or complete. In the former a certain amount of urine is never expelled, and the capacity of the bladder is proportionately diminished; in the latter it is distended until it can hold no more.

Causes.—Either the expulsive power of the bladder is defective, or there is some obstruction to the exit of the urine; or both may happen.

1. The former may arise from failure of the muscular power, or of the nervous stimuli, or of both. Atony and peritonitis, spreading to the muscular coat, are instances of the former; paralysis (from disease or injury of the spinal cord or of the sacral nerves), hysteria, exhaustion (as in fevers), alcoholic excesses, shock, and, perhaps, belladonna-poisoning, of the second. Railway accidents, operations about the rectum, such as ligature of piles, and injuries in the region of the pelvis, are especially likely to cause it; but in old people, and those in whom the wall of the bladder is already in a condition of partial atony, retention may follow the slightest accident, even a fall on the trochanter or the passage of a catheter.

2. Obstruction to the flow of urine may be situated:

(*a*) In the interior of the canal: impacted calculus, for example.

(*b*) Outside the urethra; such as a string tied round the penis by a child to check nocturnal incontinence; or the pressure of the gravid or displaced uterus.

(*c*) In the wall itself. This is by far the most common. The affection may be permanent, as stricture or enlarged prostate, or temporary, as congestion and spasm. In most cases temporary and permanent act together. An impacted calculus, for instance, may occupy only a small part of the interior, but the spasmodic contraction that it causes prevents the passage of a drop of urine; a stricture may admit a No. 3 or 4 (English) catheter the day before, and suddenly become closed in the same way, owing to alcoholic excesses or exposure to cold; and enlarged prostate may have existed for years without serious inconvenience, until suddenly congestion sets in, and the mucous membrane becomes so swollen that the weakened muscular fibre finds the task too great.

Consequences.—As the bladder fills it rises up into the abdomen and projects above the pubes as a rounded tumour, dull on percussion, and most prominent when the patient is standing. Sometimes the outline can almost be seen through the abdominal wall. It may reach the umbilicus or even the ensiform cartilage in the middle line, sloping off on either side, so that the iliac fossæ are resonant, and, especially when the walls are thin and soft, it has more than once been mistaken for ovarian tumour. In old cases of cystitis, however, in which there has been partial retention for years, and the walls are rigid and hypertrophied, and the cavity contracted, such distension is impossible, and retention with urgent symptoms may occur without the bladder being perceptible from the exterior.

The effect depends upon whether the obstruction can or cannot be surmounted. In the former case *overflow* commences; the spasm and congestion give way before the increasing pressure, and, the bladder remaining full, the urine flows away drop by drop. This condition the patient almost invariably describes as incontinence, exactly the opposite of what is correct. In the latter either the urethra gives way (*extravasation of urine*), or the pressure in the renal tubules grows higher and higher, until the secretion is stopped (*suppression*).

Retention of urine is often followed by atony; the unstriped muscular fibre of the wall is stretched until it loses its power of contracting; in some cases this condition is permanent.

Symptoms.—If obstruction is complete, so that no urine can escape, the symptoms are very serious. The pain, as the tension increases, is extreme, especially when the cavity is small, and the walls thickened and rigid, as in old cases of enlarged prostate; the patient becomes delirious; the tongue dry and brown; the pulse small and frequent; and typhoid symptoms, with extreme prostration, soon set in.

When there is a means of escape, as in most cases of stricture, the urinary organs gradually adapt themselves, and the immediate symptoms are not so urgent. It is not uncommon to find that a patient suffering from stricture, with his bladder distended far above the pubes, complains of nothing more than the inconvenience caused by the incessant dribbling of urine. In this case there is no sudden check to the secretion, but the ultimate result is no less grave, for the ureters become dilated, the kidney substance is absorbed, and chronic pyelitis and nephritis inevitably follow.

Treatment.—This depends upon the cause, but in all cases it is absolutely essential to relieve the bladder as soon as possible.

1. *Diminished power of expulsion.*—A soft catheter must be passed as often as required, with the utmost gentleness. If the condition is of long standing, and the bladder in a state of chronic distension, the amount of residual urine must be diminished gradually; sudden evacuation may cause congestion and suppression.

2. *Mechanical obstruction.*—Any cause blocking the interior, or pressing on the outside, must, of course, be removed at once. Morbid conditions of the neck of the bladder, or the wall of the urethra, require further consideration; the most important are acute inflammation, stricture, and enlargement of the prostate.

(*a*) *Acute inflammation* (*such, for example, as gonorrhœal prostatitis*).—The symptoms are exceedingly severe: the bladder soon becomes distended, and there is intense desire to pass water, with high fever and urgent distress. In many cases a catheter must be passed at once; if the patient can wait, relief can sometimes be obtained by free leeching in the perinæum, and by hot baths, the temperature as high as can be borne, for at least half an hour. A full dose of opium should be given at the same time, and the bowels opened freely. Even if this is not successful it makes it easier to pass a catheter afterwards, procures sleep and quiet, and tends to prevent the occurrence of rigors and other secondary troubles. Afterwards the patient must be kept in bed, on milk diet, without any stimulants, and the urine rendered as unirritating as possible. In cases of gonorrhœa, or when there is a prostatic abscess, this may have to be repeated night and morning for several successive days.

(*b*) *Stricture.*—In this case the distension may be so gradual that the bladder rises as high as the umbilicus, before the patient is in the least concerned about it. The urine flows away drop by drop, and this generally is the cause of complaint; there is little or no pain, and no fever, although the health is sure to fail, from the interference with the action of the kidneys. A moderate-sized catheter should be tried first, then smaller and smaller ones, but always with the utmost gentleness. The more soft and flexible the instrument, especially near the point, the more likely it is to be guided by the folds of the mucous membrane into the orifice of the stricture. Black ones, slightly bulbous at the tip, with a flexible neck, are the best: small metal ones are excessively dangerous. If these fail, a catgut bougie will sometimes succeed, and, if it passes, the urine will find its way readily by the side; but, in the majority of instances, when the constriction is so tight, it is not advisable to persist. Retention is seldom due solely to organic stricture; the urethra is narrowed by this at one point, and rendered so sensitive that the slightest irritant will close it completely, by the spasm and congestion it excites. Prolonged irritation with a catheter only makes this worse. Cocaine is of very great service; a few drops of ten per cent. solution, injected on to the face of the stricture, will frequently turn the scale; but it is better, if the catheter does not pass after a very moderate trial, to place the patient at once in a hot bath, and give him a full dose of opium. This nearly always succeeds; and generally, if he is kept in bed, on light food, without stimulants, if the bowels are kept freely open, and hot baths given night and morning, in a few days the spasm and congestion are relieved to such an extent that a catheter can be passed with ease. The only alternative is to give an anæsthetic, try again, and in case of failure puncture the bladder. The result, so far as the stricture is concerned, is the same, but at the expense of an operation.

(*c*) *Enlarged prostate.*—This may cause retention, either by the third lobe falling over the orifice, like a valve; or by sudden congestion, narrowing the elongated and tortuous passage to such a degree that the already enfeebled muscular coat is unable to overcome the resistance. The symptoms are usually very acute, the pain is exceedingly severe, and delirium and extreme prostration set in almost at once. For this, opium and hot baths can do no good, and often they are positively dangerous. A catheter must be passed at once, either a silver one with a long sweeping curve; a gum elastic, provided with a stilet, so that the end can be tilted up; or a black one with the point bent at an angle (*coudé*), so that it can ride over the obstruction. Unless a stricture is present as well, the largest catheter that will pass the meatus should always be selected, and, owing to the growth of the prostate, it should be of extra length. Violence is never justifiable, but it is often necessary, when passing a catheter under these conditions, to make use of steady but firm pressure. The urine is nearly always blood-stained afterwards, perhaps for several days, owing to rupture of the vessels in the congested mucous membrane and the blood finding its way back into the bladder.

If this does not succeed, the choice lies between forcibly pushing the catheter through the substance of the prostate or tapping the bladder.

TAPPING THE BLADDER

This may be required, either as a temporary measure, to give relief until the natural passage can be reopened, or as a permanent means of exit in impermeable stricture or enlargement of the prostate. It may be performed either over the pubic symphysis, through the perinæum (going either through or behind the prostate), or through the rectum. In exceptional instances, where, as in cases of extravasation of urine or advanced cystitis, the object is rather to drain the bladder than to relieve retention, the prostatic portion of the urethra may be opened in the middle line, at the apex of the gland (*la boutonnière*); and sometimes this is done in cases of stricture (Cock's operation).

1. *Suprapubic Tapping*

This may be performed either with an aspirator or with an ordinary but rather curved trocar and cannula. When the bladder is distended there is abundant room; but, especially in old cases of cystitis, the posterior surface of the symphysis must always be followed. If the relief required is only temporary, the aspirator may be used, a small incision being made in the skin with a scalpel, and the trocar pushed through it into the bladder, downwards and backwards. No extravasation follows, as the mucous membrane glides upon the muscular coat when the bladder collapses, and the orifice becomes valvular. If necessary, this may be repeated two or three times without much danger, and I have known it done night and morning, for more than a week, without any ill result; but, if it is continued, there is always a risk, either of leakage taking place through the wall of the bladder, or, without there being any direct opening, of an abscess forming in the loose cellular tissue, between the layers of the transversalis fascia, possibly

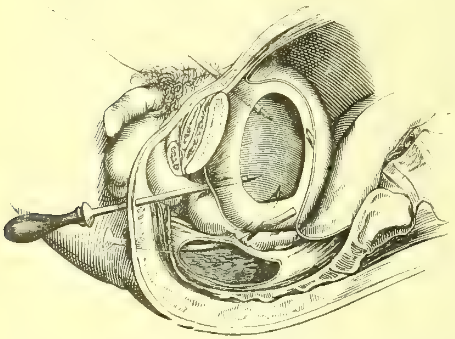


FIG. 409.—Tapping the bladder. (1) Suprapubic; (2) perinæal; (3) rectal.

due to the escape of irritating material from the end of the cannula as it is withdrawn.

When a permanent opening is required a large trocar (with a linear, not a triangular, cutting edge) and cannula may be introduced in the same way. On withdrawing the trocar a soft india-rubber tube is passed down the cannula and left when this is removed. The other end of the tube may be carried under the bed-clothes to a receptacle. After a few days the tissues become consolidated and form a short straight canal, which can be fitted with a rubber tube and stopcock. Owing to the contraction of the sinus there is no leakage, and I have known patients go about with this arrangement in perfect comfort for years.

In exceptional cases, after suprapubic cystotomy for enlargement of the prostate or tumour of the bladder, the opening has been allowed to contract to a sinus and the same arrangement made use of.

2. *Perinæal Tapping*

Post-prostatic tapping through the perinæum has recently been advocated by Howlett. The patient is placed in the lithotomy position, the forefinger of the left hand passed into the rectum as a guide, and an incision made in the perinæum behind the bulb ; a trocar and cannula is then pushed onwards between the prostate and the rectum, until the bladder is entered. This is known by the cessation of the resistance. A tube is introduced afterwards, and worn so long as the patient is in bed ; but it is only of service as a temporary measure, and the bladder, unless there is a large post-prostatic pouch, is entered at an unnecessary depth.

Harrison (see Enlargement of the Prostate) advocates draining the bladder through the prostate, but this is different from simple tapping.

3. *Tapping per Rectum*

An enema having been administered, the patient is placed in the lithotomy position, and brought down to the edge of the bed. The forefinger of the left hand is introduced into the anus, and the boundaries of the prostate examined. The finger should reach well above the upper border, and be able to feel the wave of fluctuation when the abdomen is percussed above the pubes. The bladder has often been entered through the prostate, but it is not advisable. A long curved trocar and cannula is taken, and, the point, guarded by the finger, guided to the spot where fluctuation is felt, exactly in the middle line. This corresponds to the trigone. When it is adjusted the handle is slightly depressed and driven smartly upwards and forwards, as if for the umbilicus.

There is no doubt that in this way the bladder is drained more efficiently than by the other methods, but it is not suited to cases of enlarged prostate and is impossible for a permanency. In many patients there is great difficulty in maintaining the cannula or catheter in position, even for twenty-four hours, owing to the irritability of the rectum. I have known it stitched to the skin at the margin of the anus without avail. Sometimes, it is true, if the cannula is removed the two orifices face each other again as the bladder becomes distended, and the urine is discharged into the rectum ; but this cannot be relied upon, and is attended with some danger of urinary infiltration. The space available is so small that if the tapping is repeated there is considerable risk of inflammation and even of sloughing.

In brief, where temporary relief is required, the choice lies between suprapubic aspiration and rectal tapping: neither may be repeated more than two or three times without running serious risk; but the former has a slight advantage so far as this is concerned. Where the opening must be permanent the suprapubic operation is the only one: whether it should be done with a trocar and cannula, or whether cystotomy should be performed first, must depend upon the cause of the retention and the condition of the bladder.

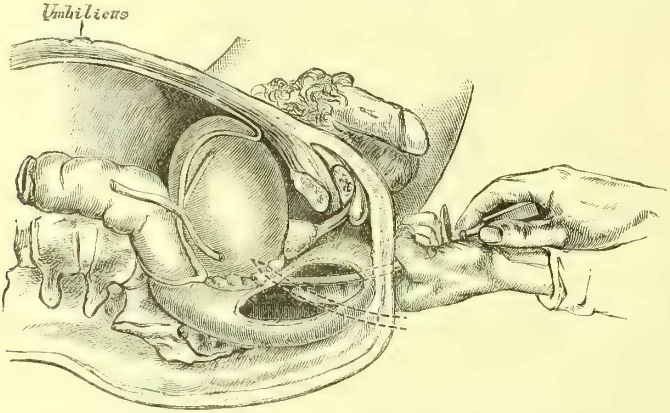


Fig. 410.—Operation of tapping the bladder through the rectum.

Cystitis

Inflammation of the bladder may be acute or chronic. Nearly always it begins on the mucous surface, and is of local origin. The chronic form may commence as such, or be the result of the acute.

Causes.—1. Injury, mechanical or chemical. The former includes wounds and contusions from calculi or instruments; tension, as in stricture and enlarged prostate; and bruising or straining as in parturition or displacement of the uterus; the latter, irritating conditions of the urine, due to uric acid, cantharides, and, more than anything else, carbonate of ammonia and other products of decomposition.

2. Infective organisms, such as tubercle, and new growths, such as carcinoma. Even non-malignant tumours of the bladder are always attended with a slight degree of cysitis.

3. Extension from surrounding parts, especially in the case of gonorrhœa and stricture. It may occur in peritonitis, and, exceptionally, in diseases of other neighbouring structures.

Pathological appearances.—In the milder forms of acute cystitis, such as occur in gonorrhœa, the mucous membrane is thickened and swollen, the epithelium detached, leaving the surface raw and bleeding, or covered over with flakes of lymph and reddened in patches, owing to small extravasations. When it is more severe it may be lined with a slough, which can be peeled off like a diphtheritic membrane; the colour is dark crimson, or, if it is some time after death, even black; the mucous membrane is sloughing and gangrenous; the submucous tissue and even the muscular coat infiltrated with pus; and sometimes the peritoneal surface involved as well, either covered with lymph from recent peritonitis, or, in the worst cases, perforated from ulceration.

In chronic cystitis the bladder is either thin-walled and distended, or small, hard, and inelastic, so that it can neither expand nor collapse. In the former case the mucous membrane is thinned and stretched and generally slate-coloured or dark from old hæmorrhages, the submucous coat can hardly be found, and the muscular fibres are wasted until scarcely a trace of them is left. In the latter the interior is rough and uneven; here and there it is bright red from extravasated blood, in other parts almost black, especially along the veins. The mucous membrane is thickened and velvety; or studded with superficial excoriations and even ulcers; and it is smeared all over with a greyish, intensely offensive, tenacious mass of mucus and phosphates. The submucous tissue in some parts is hard and dense from long-continued inflammation, in others riddled with abscesses. The muscular coat is thickened into great bands which extend around the bladder, dividing and joining again, so as to leave between them lozenge-shaped depressions. In old cases these grow out into thin-walled sacculi or pouches with very narrow necks, and, once formed, they are permanent (fig. 411); each time the bladder contracts more fluid is driven into them; there is no muscular coat, so they cannot empty themselves; and at length they become half-filled with mucus. Other pouches are sometimes due to the gradual yielding of the whole thickness of the wall; but these seldom occur unless there is a calculus (fig. 415) or a great development of the interuretral bar. In some of these the wall is forced down behind the prostate until it is possible to tap the bladder directly through the perinæum.

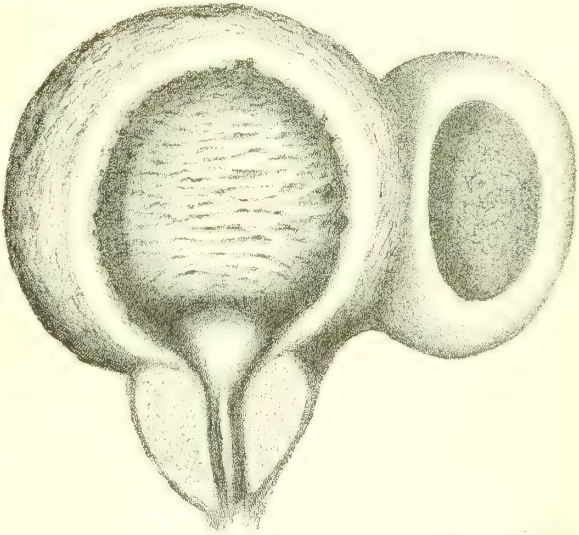


FIG. 411.—Hypertrophied and fasciculated bladder consequent on enlargement of the median lobe of the prostate. A large thin-walled sacculus with a very small orifice has been forced out on the left side.

When ammoniacal decomposition of the urine occurs in a bladder already the seat of chronic cystitis the changes are more extensive still. The walls are constantly bathed with an intense irritant; the sacculi are filled with a most offensive mixture; ulceration and sloughing follow; the pus spreads into the submucous coat and between the muscular fibres, even to the peritoneum; and at length the bladder is reduced to the condition of a sloughing abscess, filled with putrid fluid, under constantly increasing tension.

When ulceration occurs at an early period it is usually due to injury (such as the pressure of the point of a catheter tied in) or to tubercle. In the latter case the trigone is chiefly affected, and the ulcers are multiple, slightly raised at the margin, circular in shape, and covered over with a yellow granular slough. Tubercle bacilli may be found on the surface and sometimes in the urine.

In cystitis the inflammation never remains limited to the bladder for long; very soon it spreads to the ureters and involves the pelvis (pyelitis); thence it extends into the substance of the kidney itself. So long as the nephritis is not very intense, there is merely an increase in the amount of connective tissue, with some diminution of the secreting power; if, however, the urine decomposes, and the products gain the pelvis, suppuration and multiple abscesses occur very soon.

Symptoms. *Pain.*—When the inflammation is very acute, or when there is ulceration, this is described as agonising, radiating to the groins, down the thighs, and all over the lower part of the body, with unceasing desire to pass water (*strangury*), and such an amount of spasm that only a few drops of blood-stained fluid are ejected at a time. In the gonorrhœal form it is less severe; and as the inflammation becomes chronic it may almost disappear. Generally, however, there is a dull aching over the pubes and in the perinæum when the bladder is distended and as it begins to contract, when, that is to say, tension falls upon the inflamed mucous membrane; and for the same reason there is tenderness on pressure over the same regions, and on examination per rectum or with a catheter.

Contrary to what occurs in calculus, the pain is less severe after the bladder is emptied.

Increased frequency of micturition is never absent, unless there is some insurmountable obstacle. If the cystitis is severe the urine is ejected every few minutes with violent spasm; in milder cases the intervals are longer, but the call scarcely less urgent.

The character and frequently *the amount of urine* are altered. In very acute cases the quantity is greatly diminished, and it consists of little more than blood, mixed with shreds and flakes of lymph from the surface of the mucous membrane. In gonorrhœal cystitis it is cloudy and turbid with mucus; blood is usually present, especially towards the end of the micturition, when the muscles at the neck of the bladder are contracting upon the congested mucous membrane; but the amount of urine generally remains the same. As the inflammation grows chronic the hæmaturia diminishes, and may even disappear; but blood-corpuscles can generally be found in the sediment.

In chronic cystitis, so long as the urine is acid, the deposit consists only of mucus mixed with minute organisms, detached epithelium, a few blood-corpuscles, urates and oxalate of lime. When decomposition sets in the smell becomes ammoniacal and intensely offensive, and the deposit is largely increased; a thick viscid gelatinous mass gradually sinks down to the bottom whenever the urine is allowed to collect, and clings tenaciously to the sides.

The constitutional disturbance in chronic cystitis is rarely severe, though the health always suffers from the irritation and want of rest, and from the changes that are induced in the kidneys. Traumatic inflammation, if the bladder was healthy before the injury, may be attended with a certain amount of fever, sometimes with shivering; but, unless the cause is persistent, it soon subsides. In gonorrhœal cystitis the temperature occasionally ranges very high, and there is for a time great anxiety, with distress. The worst cases are those in which, owing to injury or decomposition of the urine, an acute attack suddenly breaks out in a bladder which, from atony, enlarged prostate, or any other cause, cannot completely empty itself. The urine rapidly becomes putrid; the tension grows higher and higher; the poison is absorbed through the inflamed and ulcerated walls; and owing to the kidneys being nearly always involved as well, there is very grave danger of suppression of urine. The temperature does not rise very high; but the patient becomes delirious; the most extreme exhaustion sets in; the symptoms assume a typhoid character; and death may ensue in the course of a few days.

Prognosis.—This depends upon the cause and the condition of the bladder, though naturally the secreting power of the kidneys is especially important. Inflammation, excited in a healthy bladder by a transient agent that can be removed at once, soon gets well. On the other hand, if the irritant is persistent, as in the case of tubercle or carcinoma; or if the bladder is rough and irregular, with rigid walls that cannot collapse, or studded with pouches that cannot be emptied, or if there is any obstacle to complete evacuation, the attack may be stopped for a time, but it is always ready to break out again.

Treatment. 1. *Acute cystitis.*—The first thing is to remove the cause; the second, to give the bladder rest. If it was previously healthy and the irritant was a transient one (lithotrity, for example), active local measures are not required. The patient should be confined to bed, on milk diet; the bowels thoroughly opened, and a hot bath given night and morning. If there is much pain or throbbing, leeches may be applied to the perinæum; and, if the bladder is very irritable, morphia and belladonna may be given, either in the form of a suppository or as a pessary introduced into the bladder at night. Alkalies are not of much service; but if the urine contains an excess of uric acid, ten-grain doses of citrate of potash may be given with hyoscyamus. Iced barley-water and similar drinks may be taken freely if the patient is hot and feverish; but buchu and triticum repens are of little use at this stage. If retention occurs from congestion of the mucous membrane at the neck, a soft or black catheter should be passed.

2. *Chronic cystitis.*—In this again the cause must be ascertained and, if possible, removed. Irritating conditions of the urine, for example, such as occur in gout and in ill-fed strumous children, must be treated by attention to the digestive organs. Stricture must be dilated or divided; calculi removed; vascular growths about the urethra excised; and displacement of the uterus rectified.

(*a*) *Constitutional.*—In some cases—tubercular cystitis, for example—this is almost all that can be done; in all it is very important. The clothing must be warm; exposure to cold and over-exertion avoided; diet regulated; stimulants, coffee, &c., prohibited; and the bowels kept gently relaxed. If there is much mucus (mucus does not cause fermentation of urea, but it assists it, partly by lessening the acidity, partly by coating the urethra with a stagnant layer of alkaline fluid, in which the ferment grows with ease), quinine, boracic or salicylic acid may be given internally. Benzoate of ammonia helps to keep the urine acid ; triticum repens, pareira and buchu check the catarrh, but the two last often disagree ; and copaiba, sandal oil, and other resins are of service in the same way, especially in chronic cystitis with abundant secretion. In most cases, however, when this stage is reached, local measures are required as well.

(*b*) *Local.*—Washing the bladder out is exceedingly useful in checking the formation of mucus, clearing out the adherent coating and preventing decomposition ; but it must be distinctly recognised that, unless it is done with the greatest care, it may easily do more harm than good. The utmost gentleness must be used, and, unless there is some special condition, the amount injected should never exceed four ounces. The simplest contrivance, one which the patient can easily manage for himself, is a glass funnel attached by flexible tubing to a large-eyed soft catheter. As the funnel is raised, the fluid pours into the bladder by its own weight ; as it is lowered, it falls back again ; and if it is turbid it can at once be replaced by fresh. When there is a large amount of phosphatic débris, or of thick tenacious mucus, a modification of Higginson's syringe with a double-way tap or a lithotrity evacuator may be employed ; but the amount of force must be accurately gauged with the hand. Bladders with softened walls are easily ruptured.

The most useful solutions are corrosive sublimate (1 in 10,000, with a drop of hydrochloric acid) ; iodoform, gr. x. ad ℥j, suspended in mucilage, especially for tubercular cystitis ; quinine, with a drop of sulphuric acid ; boracic acid, gr. x. ad ℥j, with glycerine ; nitrate of silver and acetate of lead. But hot salt and water, dilute nitric acid (especially if there is much phosphatic débris), permanganate of potash, sulphate of zinc or copper, and many others may be employed. It seems of some advantage, when there is much mucus, not to continue with the same one too long. Carbolic acid, unless very weak, is too irritating.

Even when the urea has decomposed and the urine is ammoniacal, so that a fresh and very grave source of irritation is added, washing out the bladder, if it is done carefully, and if the condition of the walls and of the kidneys is not too far advanced, is very successful. The germ upon which the fermentation depends is killed ; the decomposition stopped ; the excess of mucus washed away ; and the inflammation of the mucous membrane gradually subdued.

Exploration and drainage.—If this fails, the interior of the bladder may be explored either with the cystoscope or with the finger. In some instances a piece of soft rubber tubing has been found, of course without any history ; in others, a pouch spreading out from the bladder ; or a new growth ; or sometimes, especially in young subjects, a deposit of tubercle breaking down. The cystoscope may be used at an early period. Digital exploration of the male bladder necessitates an opening in the perinæum ; but the operation is an exceedingly simple one, almost unattended with danger, and in nearly all the cases in which it is required for diagnosis it is equally valuable for drainage. A grooved staff is passed down the urethra into the bladder ; the patient is placed in the lithotomy position ; a small incision made exactly in the middle line, three-quarters of an inch in front of the anus, and deepened until the finger-nail can feel the groove. Then the membranous portion of the urethra is opened above the bulb, and a probe or gorget pushed along the groove into the bladder. The staff is now withdrawn and the forefinger gently pressed through the prostatic portion, dilating it as it goes.

The further treatment depends upon what is found. If there is tubercular cystitis, and the disease is not too far advanced, iodoform or dilute lactic acid may be applied; or suprapubic cystotomy performed and the ulcers scraped, though the cases in which such a proceeding is advisable are very few in number. If there is a foreign body or a tumour, it may be removed; a sacculus may be drained; and other conditions dealt with according to circumstances.

When the cause is irremediable, as in advanced tubercle or carcinoma, simple drainage through a perinæal opening gives more relief than anything else: the patient is freed from pain; he is able to obtain a certain amount of rest at night, and, for a time at least, he may gain a certain amount of strength. Even when no cause for the cystitis is found, and sometimes it will persist in a most inexplicable manner, draining the bladder through the perinæum—giving it perfect rest for a month, and allowing all the urine to flow out through a tube—has in many instances effected a permanent cure.

This operation is imperatively required when chronic cystitis that has lasted perhaps for years, and has produced serious changes in the kidneys and in the wall of the bladder, suddenly becomes acute. This may be due to lithotrity, especially if the fragments are not thoroughly cleared away; or to the use of instruments, or to decomposition of the urine in cases of atony and enlarged prostate. The symptoms are of the gravest description: the kidneys are already in a state of interstitial, sometimes of suppurative, inflammation; there is partial suppression of urine; the bladder is unable to expel its contents; the walls are intensely inflamed, perhaps sloughing; septic absorption is rapidly taking place, and the patient is in imminent danger of sinking into a state resembling typhoid. Under such conditions there is no alternative: the bladder must be opened at once and allowed to drain just like any other offensive abscess. In many cases the patient sinks from exhaustion; but sometimes the mucous membrane clears itself with surprising rapidity; the urine loses its offensive character; the amount and the specific gravity both increase; and strength and health are gradually regained.

VESICAL CALCULUS

Calculi may be formed from any of the sediments that occur in urine, but the tendency is much greater in the case of some, uric acid for example, than in the case of others, such as phosphate of lime. The animal matter that holds the particles together is derived from the mucus of the urinary track, which undergoes a process of fermentation, and either collects layer after layer of uric acid or leads to the formation of sparingly soluble oxalate of lime.

Origin.—The nucleus of a calculus may be hollow, or consist of dried blood; in most, however, it is formed of uric acid or oxalate of lime, held together by a colloid material. These are of renal origin, though they subsequently increase by the deposit of laminæ, as they lie in the pelvis of the kidney or in the bladder. Those formed of triple phosphates are only thrown down when the urine becomes ammoniacal, and usually, therefore, originate in the bladder, though they are not confined to it.

Nuclei of uric acid are most common in early childhood and in late adult life, especially if there is a tendency to gout. The starting-point is the deposit of crystals in the secreting tubules, and most likely in the actual cells; infarcts of uric acid are often present in the renal tubules of infants shortly after birth; and in gout all stages can be traced, from crystals in the cells and irregular masses in the tubules of the medullary part, to minute calculi projecting from the orifices on the pyramids or lying loose in the cavity of the pelvis. The cause of the precipitation is probably some impairment in power of the cells, whether this arises from weakness, from exhausting illness, or from long-continued overwork, as in gout; and it is assisted by everything that tends to check the flow of urine, whether it is the small size of the secreting passages, as in children, or an actual obstruction, such as enlarged prostate. When once the pelvis of the kidney or the bladder is reached, the nucleus increases by acting as a focus around which are deposited layers that differ according to the reaction and composition of the urine.

Very little is known with regard to the formation of renal calculi, with the exception of those composed of triple phosphate, which may, of course, be formed round anything that causes decomposition of urea. It is notorious that in certain parts of England—the eastern counties, for example—they are much more common than elsewhere, but though this has been assigned to climatic conditions, the prevalence of cold and damp, the nature of the soil, and the hardness of the drinking water, it is not conclusive, though the last-mentioned cause is certainly of importance. In certain countries—India, for example—the proportion of oxalate of lime calculi is higher than in England, without any reason being known. In children of the poorer classes calculi are more common than among the well-to-do, and are nearly always composed of uric acid; possibly this arises from a deficient supply of milk and improper diet. Gravel, too, is chiefly found among those who have a tendency to gout, or who consume large quantities of animal food, or are addicted to alcohol; but though this points in a general way to increase in the tissue-waste, and to the effect of indigestion, acidity, and malassimilation, in causing the precipitation of sediments in the urine, something more is needed to explain the formation of calculi. There must be some condition of the urinary organs, leading to the production of the colloid material necessary to cement the particles together.

Calculus is more common in the male than the female; and this cannot be altogether explained by anatomy, as the same holds good with regard to the kidneys, though to a less extent. Hereditary influence probably does exist, even after full allowance has been made for the effects of locality, and for similarity of habit.

Physical characters.—Calculi vary in size from minute bodies, only larger than gravel, to masses of more than a pound in weight. The smaller ones are frequently numerous, large ones single. In shape, unless they are formed upon some foreign body, such as the end of a bougie, they are more or less rounded; but sometimes they are flattened, and occasionally they are covered with facets from mutual friction. In rare cases, where the bladder is sacculated and the calculus lies partly inside the pouch, it is moulded into the shape of an hourglass. The surface varies according to the composition, those formed of oxalate of lime being peculiarly rough and characteristic.

It rarely happens that a calculus is homogeneous throughout. With the exception of some formed of cystin, which have a peculiar radiated appearance, the surface of the cut section is made up of concentric layers, varying in character and structure according to the reaction and composition of the urine. Laminæ of oxalate of lime, more or less pure, alternate with those of uric acid; or a soft earthy layer of urate of ammonium may be interposed between others of mixed composition. Owing to the roughness of their surface and the amount of irritation they cause, nuclei of oxalate of lime are generally coated over with phosphates. Calculi sometimes suddenly undergo spontaneous disintegration, and break up. Probably the immediate cause is an alteration in the reaction or the specific gravity of the urine, so that the solubility of the different layers is no longer the same; and sometimes, after this has happened, the irritation arising from the presence of numerous angular fragments brings on an attack of cystitis, and the isolated portions become welded together again with triple phosphate.

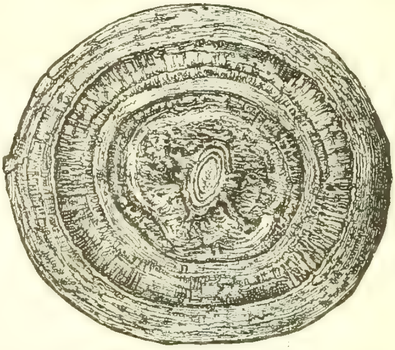


FIG. 412.—Uric acid calculus, with nucleus of oxalate of lime.

Position.—For the most part calculi lie at the back of the bladder behind the prostate; sometimes they are caught behind the pubes in front; and occasionally they lie in cysts, either large sacculi with very small openings, which are formed as hernial protrusions of the mucous membrane between the fasciculi of the muscular wall in hypertrophied bladders (fig. 411), or little cavities which the calculi work out for themselves. These are most common on the right side at the base, close to the orifice of the ureter, and they fit so accurately round the stone that it may require considerable force to dislodge it (fig. 415). All the layers of the bladder wall, very much thinned and stretched, enter into their structure, and when the calculus lies behind the prostate the orifice of the sac may be almost closed during life by the muscular bands contracting and pressing the stone deep into the substance of the gland. Phosphatic concretions are occasionally found upon growths projecting into the bladder; and it is said that calculi are sometimes adherent to the mucous surface.

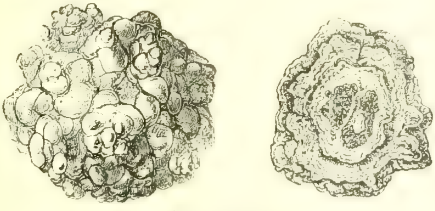


FIG. 413.
Calculus composed of oxalate of lime: surface and section.

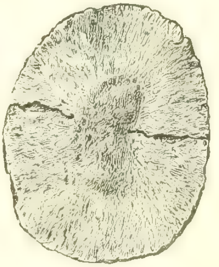


FIG. 414.
Calculus composed of cystin.

GENERAL CHARACTERS OF CALCULI

—	Shape and Size	Surface	Fracture	Colour	—
1. Uric acid	Ovoid or round, varying in size from gravel to that of a hen's egg, or even larger	Smooth, or slightly granular. Susceptible of a fairly high polish	Crystalline in proportion to purity. Brittle but hard	Yellow to red or reddish brown	Uric acid calculi are the most common of all, and are always deposited in acid urine. Usually they occur at the extremes of life
2. Urates	Ovoid, rarely so large as the former; often multiple	Smooth and earthy	Earthy and inclined to crumble. If it forms the whole, homogeneous, but in general much laminated	Fawn or whitish grey	Most common in children, mixed with lime oxalate. Usually acid urate of soda, but with some of lime and ammonia
3. Oxalates	Irregular, sometimes in the form of hemp-seed calculi	Tuberculated	Crystalline and very hard	Dark brown and even black from repeated hæmorrhages	Usually layers of oxalate alternate with others of uric or urates. Very often coated with phosphates
4. Mixed phosphates	Depends on that of nucleus	Smooth and friable	Chalky, soft, and breaking easily. Occasionally small crystals on the surface	White or grey	Only deposited after decomposition of the urea
5. Phosphate of lime, or bone earth	Rarely of any size	Smooth and soft	Breaking easily with crumbling fracture	White	
6. Cystin	Ovoid and generally of medium size	Finely granular, with small yellow crystals over it	Soft and crystalline	Yellow, turning pale green after exposure, with a somewhat radiated appearance. Waxy.	Usually pure, but sometimes on a uric acid nucleus

Chemical reactions of calculi.—The calculus should be finely pounded and divided into four parts.

1. One portion is placed on platinum foil, and heated before a blow-pipe.

(*a*) It disappears, or nearly so: uric acid or urate of ammonia.

(*b*) It clears to some extent: probably oxalate of lime; if so, the residue effervesces, and dissolves with hydrochloric acid.

(*c*) It fuses readily into a porcelain-like mass: triple phosphate, mixed with phosphate of lime.

2. The second is moistened with hydrochloric acid.

(*a*) It dissolves: oxalate of lime, phosphate of lime, or ammonio-magnesian phosphate. Carbonate of lime, and oxalate that has been heated, effervesce as well. Xanthin also dissolves.

(*b*) It remains unaltered: uric acid; urates; or cystin.

3. The third is warmed with liquor potassæ.

(*a*) It dissolves: uric acid; urates; cystin; or xanthin. The two former give the murexide reaction; the latter do not. If ammonia is present, it is given off when the solution in liquor potassæ is heated.

(*b*) It remains unaltered: oxalate, phosphate, or carbonate of lime.

4. The fourth is moistened with acetic acid; if it dissolves, it is either carbonate or phosphate of lime.

Besides these, concretions have been found in the urinary bladder, formed of fatty matter, with a certain amount of urates or phosphates (urostealith); of fibrin; blood; and even of indigo, derived from the indican; but they are all extraordinarily rare.

Symptoms.—The cardinal symptoms of stone are pain, increased frequency of micturition, hæmaturia, and sudden stoppage in the stream of urine. They are worse with small calculi than with large ones, because the latter remain stationary in the bladder, and do not roll about and irritate the mucous membrane; they are more marked when the bladder is empty, because, so long as it is full, the calculus lies in a fluid of higher specific gravity than water, and, though it does not actually float, it cannot come into forcible contact with the walls; they are worse with oxalate of lime calculi, because their surface is so rough; and most severe of all when the mucous membrane is inflamed.

1. *Pain.*—This is of two kinds. The one is a constant, dull, aching sensation, across the loins, in the groin, and running down the thighs; worse on movement, especially riding, driving, or jumping. The other, which is more characteristic, is an intense cutting or shooting pain, felt at the end of the penis as the fluid leaves the bladder, and the sensitive mucous membrane at the neck is crushed down upon the rough and hard surface of the calculus. Children, towards the end of micturition, scream with pain, and pull upon the penis, until the prepuce is immensely elongated. Violent straining often occurs at the same time, the contents of the rectum are discharged involuntarily, and the mucous membrane, especially if any piles are present, often becomes prolapsed.

2. *Increased frequency of micturition.*—This is especially marked during the day time, while the patient is moving about: at night, contrary to what occurs when there is enlargement of the prostate, the bladder is at rest, because the stone is quiet. When cystitis sets in, this symptom is very troublesome.

3. *Hæmaturia.*—Blood is frequently present in the urine after exertion;

but it is only characteristic if the urine itself is clear, and at the end of micturition, when the pain is coming on, a few bright red drops follow.

4. *Sudden stoppage of the stream of urine.*—This is not so common; it may occur, however, from the stone falling against the neck, especially in children, and setting up spasmodic contraction of the sphincter.

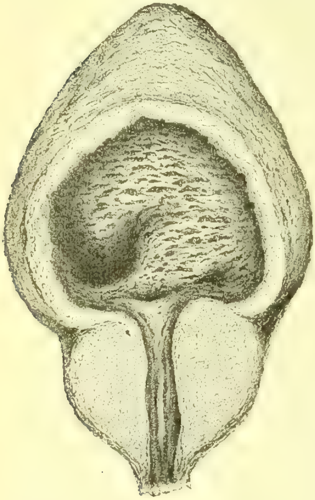


Fig. 415.—Hypertrophied and fasciculated bladder, with enlargement of prostate. A calculus was buried in a deep pouch behind the gland, and the orifice was so firmly contracted around it that at the post-mortem there was some difficulty in dislodging it.

Latent calculus.—The symptoms of calculus are occasionally masked to such an extent that its presence is never even suspected.

This may occur with very large, smooth, and rounded calculi. They remain perfectly quiet; there is no hæmaturia, pain, or spasm: merely increased frequency of micturition, owing to the diminished capacity of the bladder. Stones of over a pound in weight have been found, *post mortem*, without the inconvenience ever having been sufficiently great to make the patient apply for treatment.

It may also happen if the prostate is much enlarged, without there being any cystitis. The calculus remains behind the projection, and never comes into contact with the neck; the symptoms never become urgent. Chronic inflammation of the bladder is always present in encysted calculus.

Consequences of calculus.—Inflammation always breaks out sooner or later; at first the mucous membrane only is involved, but very soon it spreads to the submucous and muscular coats; the cavity shrinks, the walls become rigid, inelastic, and irregularly thickened; sometimes sacculi develop or ulceration sets in, and the mucous membrane becomes coated with an intensely offensive layer of putrid pus and triple phosphates. Dilatation of the ureter and of the pelvis of the kidney always follows: the cortex is absorbed; the connective tissue increases in quantity; the secreting power is diminished; the urine becomes ammoniacal, and the inflammation rapidly spreads upwards, involving the pelvis and the substance of the kidney, and causing suppurative pyelonephritis.

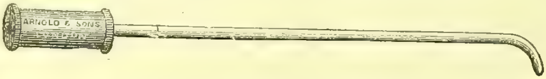


Fig. 416.—Sound with bulbous end.

Diagnosis.—The presence of a calculus can only be proved by exploring the bladder with a sound or a cystoscope.

Sounds are made of steel for the sake of the polish. The handle may be cylindrical, or flattened and rougher on one surface than the other, so that there may be no mistake as to the direction of the beak. The shaft is round, nine inches in length, and about the size of a No. 7 English catheter; the beak is an inch and a quarter in length, slightly bulbous at the end, and is bent up to an angle of 120°. For children, of course, they are smaller. Sometimes it is of advantage to have them hollow, so that the amount of fluid in the bladder can be varied. With children it is always advisable to give an anæsthetic; in an adult an injection of cocaine does a great deal towards diminishing the discomfort.

The same precautions should be taken in passing a sound as in passing a catheter. Fatal consequences have occurred even in children with perfectly healthy kidneys. The patient should, if possible, be prepared beforehand, and should remain quiet afterwards. It is best if he will keep his room, and if there is the least suspicion with regard to the kidneys, even his bed, for the rest of the day. A large cupful of hot tea with five grains of quinine, and a few minims of laudanum, is an excellent precaution. If there is any retention afterwards it may be relieved by a full dose of opium (provided the kidneys are not affected) and a hot bath.

For choice, the bladder should contain four or five ounces of urine; if there is more than this, a small calculus may easily elude the sound; if less, the folds of the mucous membrane may collapse around it and cover it in. In children and young adults, in whom there is no reason to suspect chronic retention, it is sufficient if the bladder contains the secretion of the last hour or two; but in older men, with possible atony and enlarged prostate, or where there is any difficulty, it is better to pass a soft catheter first, empty the bladder thoroughly, and then inject it with four or five ounces of warm boracic solution.

The patient should be lying down, with the head comfortably supported upon a pillow, the pelvis slightly raised, and the knees and hips flexed and rotated outwards. The sound, of course, must be warmed and well lubricated, preferably with Lund's oil.

In sounding a bladder a definite plan should be followed. The upper part and the sides are examined first, as the point emerges from the prostatic portion of the urethra, not forgetting that a calculus is sometimes held against the pubes, even when the patient is lying down; then the handle is depressed, the beak inverted, and the floor, and the pouch that exists in so many cases behind the prostate, carefully felt all over. Rapid or rough movements must be strictly avoided: the former give rise to waves which may drive a light calculus away; the latter may injure the wall of the bladder. Digital examination of the rectum at the same time should never be omitted, particularly with children.

The contact of the sound with the stone must be heard as well as felt, and an attempt should be made to ascertain further details. Sometimes the material of which the stone is composed may be conjectured from the character of the sound it gives when struck. If it is oxalate of lime, the ring is clear, as against metal; if uric acid, it is more dull, like stone; if the outer crust is composed of triple phosphates, there is merely a rough grating sound. In the same way a general idea may be gathered with regard to the size and number; but, to obtain definite information, a lithotrite must be used, and even then, if, for example, the calculus is a very flat one, it is not always possible to be certain; one stone must be grasped first, its measurement taken, if possible, in more than one diameter, and then the instrument used as a sound to detect the presence of others. Besides this, the position and mobility of the stone, whether it is encysted or not; the state of the bladder as regards irritability, softness, or hardness of the walls, whether it is smooth or covered over with rugæ; the size and prominence of the prostate; and the condition of the urethra, should all be noted. Very often the method of operation is determined to a large extent by some detail of this description.

Errors may arise in various ways. Not unfrequently a calculus is missed, even after repeated examination. There is too much fluid in the bladder, and the stone floats away before the sound; or too little, and it is enveloped in folds of mucous membrane. Sometimes the sound never reaches the bladder at all, but stops in the prostatic portion of the urethra, or in the enlarged and dilated prostatic sinus. More often the stone is missed just at the neck, because the sound is not rotated soon enough after entering the bladder. Calculi lying in cysts are always difficult, owing to the very small size of the opening; and after lithotrity minute fragments covered over with a layer of coagulated blood may easily escape notice.

The opposite error, imagining that a calculus is present, is more serious. In children, in whom the wall of the bladder is very thin, the sacral promontory and the spine of the ischium, if struck smartly with a sound, give something of the same sensation, though the ring is not clear. A rough and fasciculated condition of the wall of the bladder, especially if the rugæ are coated over with phosphates, and tumours encrusted in the same manner, sometimes raise a momentary doubt; and the same thing may occur after lithotrity, when the bladder is being washed out, from the mucous membrane suddenly flapping with an audible click against the orifice of a large and straight evacuator.

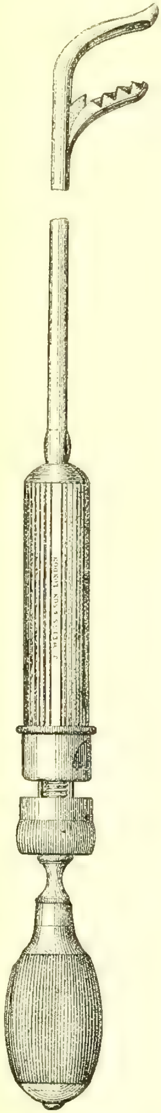
The other methods of examining the bladder can only be regarded as accessories to the sound. The cystoscope, except in the case of a sacculated bladder, gives little or no further information.

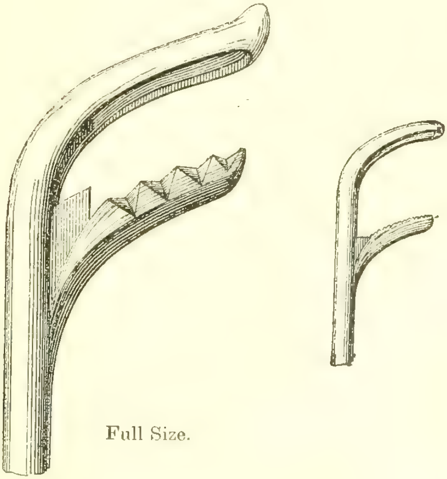
With very few exceptions, calculi must be removed from the bladder by crushing or cutting; solution is rarely worth the trial. As the former is more common, and has to a great extent superseded the latter, it will be taken first.

LITHOTRITY

The modern operation owes its position to Bigelow, who, in 1878, recognising the immense power of dilatation possessed by the urethra, and the ease with which the fragments of a calculus can be extracted by suction, proved that a stone could be crushed and removed, once for all, with far less risk than when the operation was repeated many times successively, and the bladder in the meanwhile left full of sharp angular fragments, any one of which might become impacted at any moment.

Lithotrites for large calculi must be cut from a solid bar of steel; those for finishing the fragments may be forged. The principle is the same in all: a male blade gliding on a female one, and capable of being screwed down into it with immense force. The jaws are modified according to the kind of work; in the larger instruments the female is pierced at the base, so that it cannot become clogged with débris, while the male is deeply cut into sharp-edged notches, so that the calculus may not slip; in the smaller ones both are solid and the surfaces are smoother. The male is narrower than the female, to avoid the risk of catching the mucous membrane. In one of the latest patterns (Reliquet's) the teeth of the female blade are directed transversely and obliquely, so that the calculus cannot slip towards the point when the male one comes down upon it; and the teeth of the latter, which act singly upon the stone, pass through the fenestræ of the female so as even to project beyond. The handle varies a good deal, but in all it is so contrived that while the male blade can glide up and down freely in the female for the purpose of seizing the calculus, it can be fixed at any point by simply touching a catch, and then can only be moved by the





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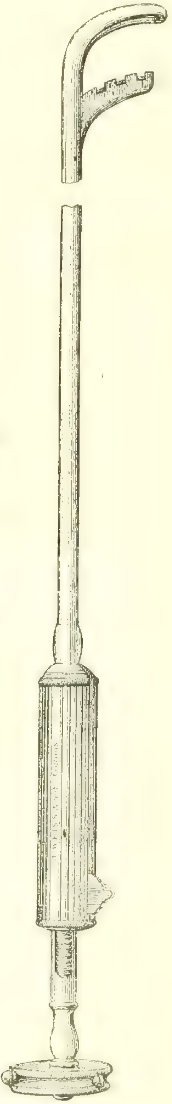

FIG. 417.—Bigelow's lithotrite.

FIG. 418.—Thompson's lithotrite.

screw. The largest instruments, the end of which is prolonged into a kind of beak, are about the size of No. 16 (English); the smallest, No. 8.

The other instruments required are a set of steel sounds, highly polished, for the purpose of dilating the urethra; evacuators, thin-walled metal tubes, straight, or curved like a catheter, varying in size from No. 8 or 10 to 18 (English), each having a single large opening at or near the end, on the convexity or in the hollow of the bend, so as to suit all conditions, and an india-rubber aspirator (fig. 421) which can be fitted on to the end of these by means of a short piece of flexible tubing. Various forms have been devised to prevent the entry of air, regulate the flow of liquid, and trap the fragments as they are sucked out. They are all filled from the top by means of a funnel closed with a stopcock; some are fitted with a wire valve, which, however, is liable to become clogged; in others the glass receiver, which should always be below the aspirator, is so placed that the fragments are conducted at once to the bottom, and the fluid drawn away from the top. Perhaps the most convenient, except that its connection with the tube is rigid, is the one described by Bigelow in the 'Lancet' (Jan. 6, 1883), as it can be filled with clean water without disconnecting.

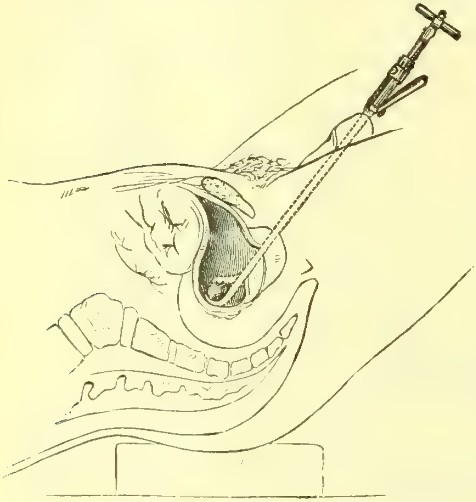

Fig. 419.—Operation of lithotrity.

The rectum should be emptied the morning of the operation by means of an enema, and the patient placed under an anæsthetic. Cocaine may be used for small calculi if the patient is accustomed to the use of instruments. The pelvis should be slightly raised, and care should be taken that the chest and limbs are well covered up, as the operation may last a considerable time.

A steel sound is passed first to dilate the urethra and to ascertain its size. As a rule an evacuator equal to No. 16 (English) can be passed without difficulty, and sometimes even No. 18, though it may be necessary to slit the meatus down by the side of the frænum.

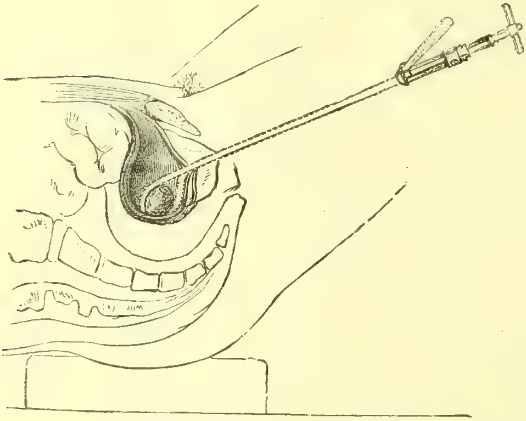

Fig. 420.—Operation of lithotrity.

If the patient's bladder is not irritable and is known to contain a certain amount of urine, it may be left; but in most cases it is advisable to withdraw the contents, and inject four or five ounces of a warm antiseptic solution. The choice of lithotrite must be guided by the size and composition of the calculus. If it is large the instrument should be of proportionate strength and the jaws deeply cut, the female being fenestrated; if small or soft, such as a phosphatic concretion, a medium-sized one may be used from the first. If a sound passes easily, it rarely happens that there is any difficulty in the introduction; the instrument must be warmed and oiled, and then allowed to slip down by its own weight, not letting it pass beyond the perpendicular until the beak has glided well below the pubes.

There are two methods of seizing the calculus. In the first the closed lithotrite is allowed to rest with the convexity upon the fundus of the bladder, and the male blade withdrawn (fig. 419); very often, on pushing it down again, the stone is grasped at once, or, if not, is felt to slip to one side or the other, so that its position is known. In the other the handle of the instrument is depressed until the beak occupies the centre of the bladder, the blades reversed, and the stone picked up from the floor (fig. 420). The former answers for the first crushing; the other is the better when the prostate is enlarged, and when fragments have to be dealt with. The instrument, as it were, swings on a pivot formed by the fixed portion of the urethra; if it is steadily held, the fragments, as the stone is crushed, drop vertically down, and can be picked up again one by one with the minimum of manipulation.

With soft phosphatic concretions the crushing can be effected by the hand; in other cases, as soon as the stone is grasped, the male blade is fixed with the catch, the instrument gently brought to the centre of the bladder so as to make certain that the mucous membrane is well out of the way, and the screw driven home until the calculus yields. If the fragments are large they may be crushed with the same lithotrite, but as soon as the bigger ones are disposed of a lighter instrument is better. Great care must be taken before it is withdrawn that the male blade is well home, and that no débris is entangled in the jaws. Dragging out fragments of the calculus, tearing the mucous membrane of the urethra, is a most dangerous proceeding. A smart tap on the handle, or working the blade backwards and forwards, nearly always releases it. If possible, before the second lithotrite is removed, the calculus should be thoroughly crushed, so as to reduce the number of occasions on which an instrument is passed as much as possible.

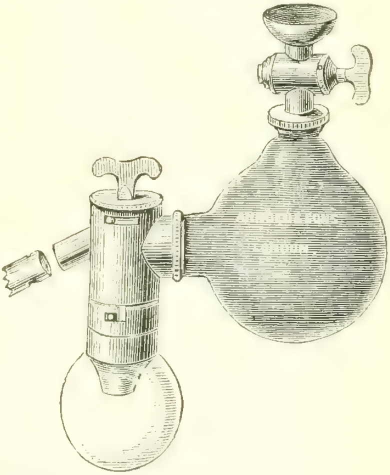
FIG. 421.—Thompson's bladder-aspirator.

The evacuating tube should be the largest the urethra will admit without straining. Curved ones pass more easily, but Bigelow prefers them straight. If the fluid from the bladder does not at once rise up in the tube, it must be filled with a syringe so that no air can enter; but a careful record must be kept as to the quantity. The aspirator introduces from one to three ounces more, and though the total will not nearly fill a healthy bladder, it is quite possible to tear the walls if they are thinned and softened from atrophy and fatty degeneration. On the other hand, if there is too little (and occasionally a certain amount is lost when the instruments are changed), the mucous membrane may be sucked into the orifice of the tube and badly bruised. The injection should be slow, but the bulb quickly released, so that it expands rapidly, and the end of the tube should be moved gently about the fundus, especially if there is a post-prostatic pouch, to search the fragments out. Sudden stoppage of the current is due to the tube being accidentally withdrawn into the prostate, to the bladder becoming empty, or to the impaction of a large fragment in the eye. This can be recognised by the sharp clear sound, and the sensation as it strikes against the side of the tube. When the calculus is large it is often necessary to withdraw the evacuator after some has been removed, and re-introduce the lithotrite, but this should be avoided if possible.

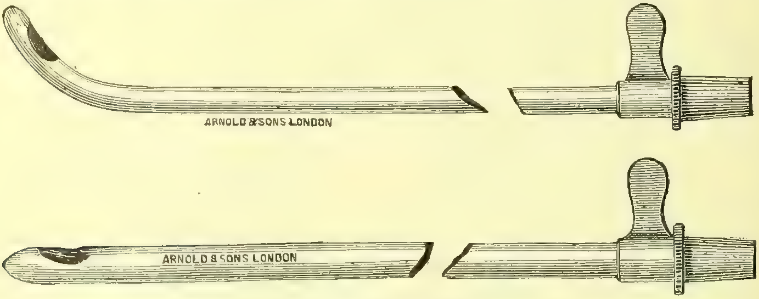

FIG. 422.—Evacuating tubes.

At the end of the operation the bladder should be washed out with some clear fluid to make sure that no fragment is left. In the case of small calculi there is no bleeding, but with large ones and prolonged manipulation, especially where the veins are much dilated, it is scarcely possible to avoid it altogether. It is especially desirable to avoid leaving any fragment behind. The opprobrium of lithototrity is that the relief is not permanent—that recurrence takes place much more frequently than after lithotomy; and there is no doubt that it is to a great extent true. Sometimes the reappearance of calculi, as in the case of phosphatic concretions in old men with enlargement of the prostate, is due to entirely independent causes; but it must be admitted that occasionally small fragments are left (they may be passed subsequently by the patient) and form a fresh nucleus.

After-treatment.—If the urine is acid and the bladder and kidneys sound, the after-treatment of the case is exceedingly simple. There is always a certain amount of irritation, owing to the prolonged manipulation; but, as the cause is removed, this soon subsides. The patient should be kept in bed for a day or two; a hot bath may be given at night; the diet should be light and unstimulating; and if there is much pain or tenesmus, or if retention is threatened, a few drops of a solution of morphia may be introduced just inside the neck of the bladder, or an opium suppository placed in the rectum. Unfortunately, when the urine is alkaline and the calculus phosphatic, and still more when the kidneys are diseased, even though the stone is softer and the amount of manipulation less, the risk of complications setting in, and of after-troubles, is very much increased.

Serious accidents may occur during the performance of lithotrity, without its being possible to allege undue violence. Hæmorrhage is rarely of consequence, but in a few cases it has been excessive, probably from the rupture of a varicose vein filling the bladder with clot, and placing the patient in danger of septic decomposition and cystitis. The male blade may become so fixed that it is difficult to dislodge the fragment and in one or two instances it has been necessary to open the bladder and free it before it could be withdrawn. Rupture of the bladder into the peritoneal cavity has occurred; and occasionally the urethra and the prostate are so bruised by the frequent passage and manipulation of very large instruments, that inflammation, and even suppuration, have followed. Impaction of a fragment at the neck of the bladder, which used to be not uncommon, is scarcely ever met with under the present system.

Complications.—Lithotrity, like all other operations on the urinary organs, may be followed by consequences, some reflex, others inflammatory.

(*a*) *Reflex.*—The *shock* may be general and prove fatal, even when the kidneys are sound; or it may affect the vaso-motor nerves of the kidneys, causing *partial or complete suppression* of urine; or the muscular wall of the bladder (*atony*). This last is especially frequent in the case of old men with enlargement of the prostate, in whom a certain amount of difficulty exists already. In addition *rigors* may occur, and *urethral fever* may set in acutely, or, more often, insidiously, associated with partial suppression, and ending in prostration and delirium.

(*b*) *Inflammatory.—Cystitis* is the most common. In many cases it exists already, but if it is recent, and the stone the only cause, it soon subsides. When the walls of the bladder are rough and irregular, covered over with sacculi, and lined with a thickened and perhaps ulcerated mucous membrane—such a condition as commonly occurs in old cases of cystitis associated with enlarged prostate—the risk is very different. If decomposition of the urine sets in, the inflammation at once becomes intense; the mixture of mucus and blood with ammoniacal urine, kept at the temperature of the body, becomes offensive to the last degree; and unless free exit is given at once, either the patient dies of septic absorption from the putrid mass, or the inflammation spreads to the ureters and ends in acute pyelonephritis.

Inflammation may also occur *in or around the prostate* and at the neck of the bladder, especially after the use of large tubes; *epididymitis* is not uncommon; *peritonitis* may be caused by direct extension; and, particularly when the large plexuses at the neck are bruised and injured, *phlebitis* may occur, and lead either to *thrombosis of the veins* of the extremities or to general *pyæmia.*

In all cases of chronic cystitis there is great risk of recurrence; possibly minute fragments of the original calculus are left embedded in the mucus; possibly fresh concretions are formed from the accumulation of phosphates on the walls; and in all such cases crushing often has to be repeated at intervals of a few years.

There are certain conditions in which the difficulty of performing lithotrity is so great, or the after-consequences so serious, that it is advisable to select some other method.

1. *Age.*—It has been shown by Keegan and others that lithotrity may be performed with perfect safety in children only three and four years old. The meatus is almost uniformly too small, but the urethra will usually admit a No. 7 (English) lithotrite and evacuating tube, and with this it is possible in a reasonable time to remove a uric acid or oxalate calculus of moderate size. In other respects, the small size of the prostate for example, the healthy tone and condition of the walls of the bladder, and the state of the kidneys, children form exceptionally good subjects.

2. *Stricture.*— In ordinary cases this can be dilated or incised first; but where there is a large amount of inflammatory exudation, forming a dense mass in the perinæum, suppuration with urinary abscess is not unlikely.

3. *Enlargement of the prostate* by itself, without atony or cystitis, is of little or no consequence; the only difficulty is that of picking up the stone and the fragments from the pouch that forms behind; sometimes this can be facilitated by moderate distension of the rectum.

4. Similarly, *atony of the bladder*, without cystitis, does not preclude crushing, so long as the condition is recognised. The danger is that it sometimes occurs unexpectedly, and that a quantity of fluid in a state of putrefaction is left stagnant in the bladder.

5. *Cystitis.*—Where it is slight, caused by the calculus itself, and there is no permanent change in the wall, cystitis is not serious. On the other hand, if the urine is ammoniacal and deposits large quantities of ropy mucus; if the walls are fasciculated, and the lining membrane softened and coated over with a mixture of mucus and phosphates, the question becomes grave. Such a condition is always associated with disease of the kidneys, and if serious consequences do not arise from this, the inflammation about the bladder is almost sure to be made worse, and perhaps become diffuse; suppuration may occur around the prostate; or peritonitis set in, especially if there are sacculi; or the inflammation may extend up the ureters and cause acute septic pyelonephritis.

6. *The condition of the kidneys.*—When they are diseased, any operation about the urinary tract is liable to be followed by partial or complete suppression of urine, urinary fever, or diffuse inflammation and even sloughing; and there is no doubt that lithotrity is especially exposed to these dangers; the only point is whether, in this respect, it is in any degree worse than lithotomy.

7. Lithotrity may be impossible owing to the size and hardness of the stone. Calculi of over three ounces in weight have been removed by crushing, the sitting lasting as long as four hours; but, as a rule, if composed of unmixed oxalate of lime, it is very difficult to crush one that measures an inch in diameter. The same thing may happen from the position of the stone. A calculus lying in a sacculus, or embedded in a cavity it has worked out for itself, often cannot be crushed. It is true that no operation can boast of much success under such conditions, but lithotrity is especially bad; the wall of the cyst is exceedingly thin; the cavity, as it cannot be emptied, is left full of the débris; septic cystitis is almost certain to follow, and peritonitis and even sloughing of the wall may occur.

When the calculus is tightly grasped, so that it cannot be dislodged without using excessive force, it is better, if the patient is an old man, to leave it alone; of the two evils, it is the least.

LITHOTOMY

The bladder may be approached either through the perinæum or above the pubes. In exceptional cases calculi have been removed through the vagina and the rectum. The patient should be prepared in the same way as for lithotrity—a purgative given the day before and an enema the morning of the operation.

PERINÆAL LITHOTOMY

1. *Lateral lithotomy.*—The deep incision carried through the membranous and prostatic portions of the urethra, into the left lobe of the prostate. The instruments required are a sound; a grooved staff, either straight or curved; lithotomy tapes, anklets, or Clover's crutch for fastening up the patient; a lithotomy knife, or broad-bladed, straight-backed scalpel; various kinds of forceps and a scoop. A catheter and a syringe for injecting the bladder, or washing it out after the operation; a blunt-pointed gorget, when the perinæum is too deep, or the prostate too large for the finger to enter the bladder; and a petticoated tube, or india-rubber tampon, in case of deep hæmorrhage, may be required as well.

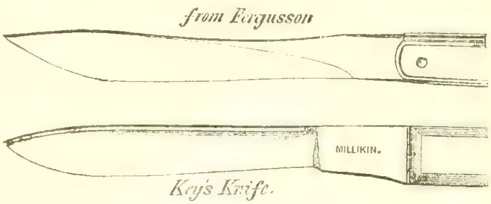

FIG. 423.—Lithotomy knives.

The table should be narrow, and of a convenient height, so that the operator has not to raise his hands too much. If Clover's crutch is used, the anklets and the strap may be placed in position while the anæsthetic is being given. It consists of a metal bar to place between the legs, with a semi-circular padded crutch at either end. The legs are flexed upon the thighs; the bar, which is provided with a sliding rod fixed by means of a screw at any required length, placed between them; and the anklets fastened round the limbs, immediately below the knee. The thighs are bent upon the abdomen; a soft leather strap passed behind the shoulders, and the free ends buckled to the crutches, so that when it is tightened up the limbs are absolutely fixed. Then the knees are separated to any extent by the sliding rod. If bandages or tapes are used, the patient's hands must be made to grasp the soles of the feet, the bandage being fixed first by a clove-hitch round the wrist, and carried round hand and foot together in a figure-of-eight.

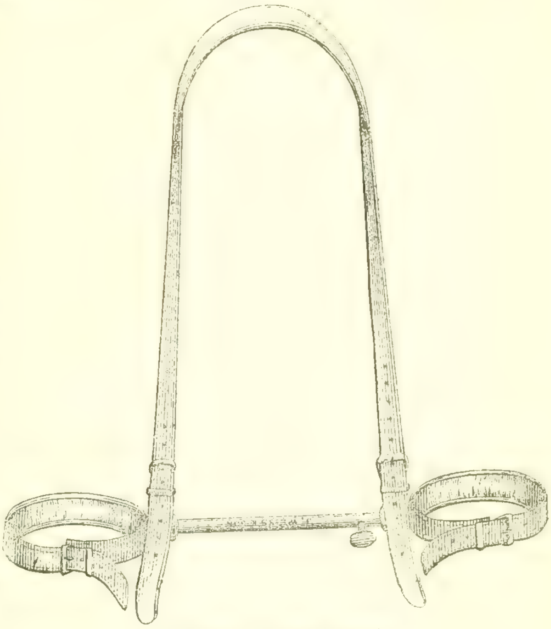

FIG. 424.—Clover's crutch.

The staff may be introduced either before or after the patient is tied up. The former is the easier, but care must be taken in moving the limbs that the point is not driven through the wall. It is absolutely essential that the stone should be felt with it before the operation is commenced, and it is a wise precaution for one of the assistants to feel it as well. If the patient has not passed water recently, and the bladder appears to contain sufficient, there is no need to pass a catheter; but when there is any doubt it is as well to empty it, and replace the urine by six or eight ounces of some warm antiseptic fluid.

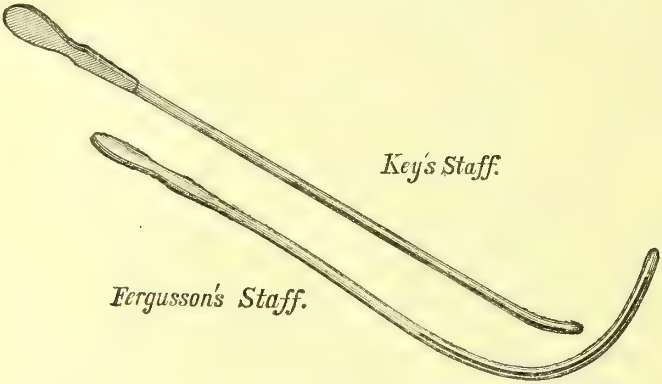

Fig. 425.

The patient is brought down to the edge of the table, so that the nates project slightly over it, the limbs fixed in position, the perinæum shaved, and the staff given to a third assistant to hold. If it is a curved one, it should at first be slanted a little towards the abdomen, and gently pressed down in the perinæum, to bring the membranous portion of the urethra towards the surface; as soon as the groove is felt, it should be raised to a vertical position, and pulled well up under the pubes for the deep incisions. The shaft should be grasped firmly with the fingers, and the ball of the thumb pressed against the flat part of the handle. If the staff is straight, it is held well up with the handle pointing slightly towards the operator, until he takes it himself.

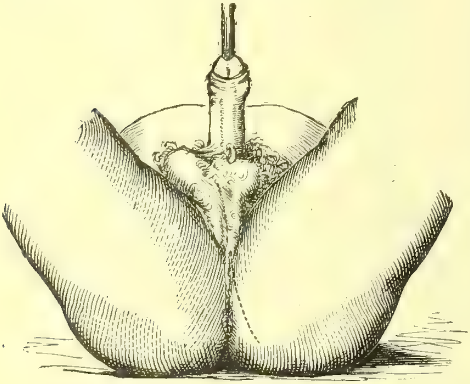

Fig. 426.—The incision for lateral lithotomy.

Before beginning, the forefinger is introduced into the rectum to feel the prostate, to make sure the rectum is empty and the staff in its proper place, and stimulate the gut to contract out of the way. Then, steadying the skin with the left hand, an incision is made from a point midway between the scrotum and the anus, commencing close to, but not at, the middle line, downwards and outwards for about three inches (in an adult) to a point nearer the ischial tuberosity than the anus. This divides skin, superficial fascia, subcutaneous fat, external hæmorrhoidal vessels (which may bleed freely for a moment), and perhaps the superficial perinæal vessels and nerves. The incision is then deepened by dividing the transversus perinæi muscle, with the artery upon it and the lower border of the triangular ligament, the forefinger guarding the rectum in the wound. The bulb should not be touched, though the fibres of the accelerator urinæ may be exposed and even divided.

The finger is then pressed into the upper angle of the wound, to feel for the staff, and the knife passed along it until the point is lodged in the groove. The staff is then raised to the vertical position, and hooked well up; and the knife, with the edge turned towards the tuberosity, is carried forwards in the groove until it is stopped at the end, dividing as it goes the compressor urethræ and the membranous portion of the urethra, the deep layer of the triangular ligament, the left lobe of the prostate, some of the fibres of the levator prostatæ, and the ring at the neck of the bladder; the incision, of course, not being deeper than the blade. It is then withdrawn, the edge still pointing towards the right, so that it faces the longest diameter of the prostate, and as it comes, being gently drawn downwards and outwards, to enlarge the incision on the under surface of the gland. The fibrous ring at the neck of the bladder is notched so that it yields readily; in doing this the plexus of veins may be laid open, and in old people they are not unlikely to bleed profusely; but, if the cut is not deeper than this, there is no fear of infiltration of urine.

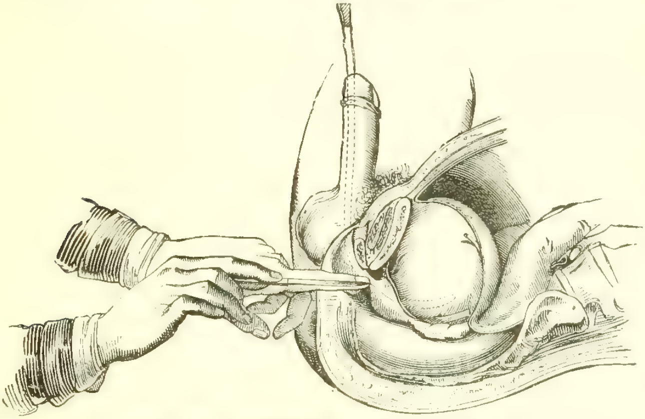

Fig. 427.—Lithotomy with the curved staff.

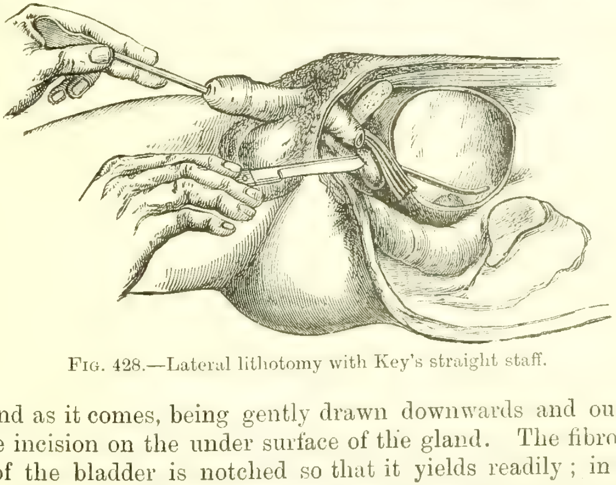

Fig. 428.—Lateral lithotomy with Key's straight staff.

If the incision is too small, the tissues are so bruised in the process of extraction that diffuse inflammation is very likely to follow. If it is too large, passing through the plexus into the rectovesical fascia and dividing the lateral true ligament of the bladder, urine is almost certain to be extravasated into the deep cellular tissue. The staff must be held well up against the pubes, the point of the knife not allowed to leave the groove, and the blade kept in a line with the staff, except in withdrawing it quite at the end. If this is carried out, it is almost impossible to wound the floor of the bladder, and the incision is sufficiently large to admit the finger with a little gentle pressure. When the calculus is felt, if it is thought that there is not sufficient space, it is easy to divide anything that resists with a probe-pointed bistoury.

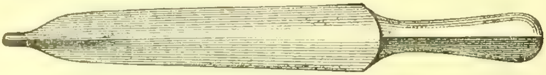

FIG. 429.—Blunt gorget.

With a straight staff the process is slightly different; the preliminary steps are the same, but as soon as the point of the knife is placed well in the groove, the operator takes the staff himself with the left hand, lowers it until it is nearly horizontal, holding the point of the knife meanwhile quite still, and then, turning staff and knife together on their long axis, so that the latter is in the proper plane, pushes it on until the resistance of the prostate is no longer felt. The extent to which the gland is divided depends upon the angle formed by the knife with the staff. With a straight instrument used in this way as a director, it is much more easy to keep the knife in the groove and to make an incision sufficiently free without being too wide.

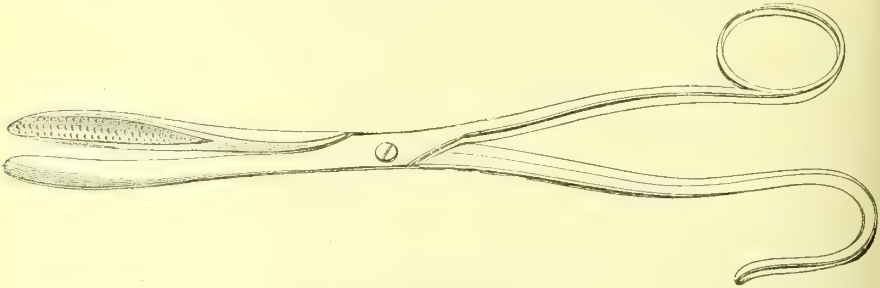

FIG. 430.—Lithotomy-forceps.

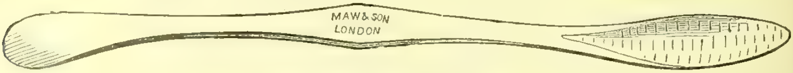

FIG. 431.—Lithotomy-scoop.

As soon as the knife is withdrawn the finger is gently wormed down the groove without using any force, dilating the tissues until it enters the bladder and feels the calculus. Then, and as a rule not till then, the staff may be removed. In the case of a very deep perinæum or very large prostate, where the finger is too short to reach the bladder, a blunt gorget may be passed along the groove to open up the route for the forceps; or a director may be used to keep the line of the urethra and act as a guide after the staff has been withdrawn. As soon as the finger feels the stone, a suitable pair of forceps, warmed, must be guided through the wound into the bladder and the blades gently separated. Withdrawing the finger is followed by a gush of urine which may carry the calculus at once into the grasp of the forceps, or a slight movement of the blades may enable it to be seized; but often this is the most difficult part of the operation. The blades should be opened laterally, and the lower one made to sweep along the floor; if this fails, the stone may be caught behind the prostate, or above the pubes, and the forceps must be withdrawn to the neck, and the handles raised or lowered. Sometimes the difficulty arises from the size of the calculus, or from its shape, and it may be necessary to remove the forceps and introduce a larger pair, or to manipulate the stone with the finger so that it may be caught in another diameter. If it breaks up, it must be extracted with the finger and a scoop, washing the bladder out afterwards to remove the débris. Everything must be done slowly, gently, and methodically; the direction of the forceps must be in the axis of the pelvis; the traction must be straight, without rotation; if there is much resistance, the tissues in front of the stone must be felt with the finger; sometimes they can gently be pushed off it; or they may be notched with a scalpel; or if the obstruction can be felt all round, and it is clear that the incision is too small, the forceps may be removed, the stone allowed to drop back, and the tissues that resist divided, as far as is prudent, with a probe-pointed bistoury, using the finger as a guide. By this means, in an adult, a stone an inch and a half in diameter may be removed without dividing the lateral ligaments and without too much bruising; one two inches across may possibly be extracted by drawing it well down and carefully dividing the tissues that resist, or incising the other side of the prostate; but in such a case it is better either to perform the suprapubic operation, or to crush the calculus first and then extract the fragments. Under no conditions may the incision be made first, and then the stone broken up by instruments introduced through the wound. The fracture of a calculus, even when held in the forceps, adds materially to the risk, owing to the necessity of washing out the bladder to get rid of the fragments.

The last step in the operation is to explore the bladder with the finger, to make sure there is no other calculus present.

Unless hæmorrhage is feared, there is no need to leave a tube in the wound. If the bladder and kidneys are sound, it is quite possible, especially in children, to secure union by the first intention, which this, of course, would prevent. As a rule, the urine flows away through the opening for the first two days, and then, owing to the swelling about the prostate, some, and occasionally all, comes by the urethra. When suppuration begins it pours out of the wound again, the amount gradually diminishing as healing progresses. The patient should be placed in bed, on his back, on a divided mattress protected by a waterproof. The hips and knees should be bent, and the legs supported by pillows. Dry sponges wrung out of carbolic solution and frequently changed, or wood-wool, may be used to absorb the urine and the discharges of the wound. Every endeavour must be made to keep the skin dry and to prevent excoriations; especially in old people, and where the urine is ammoniacal, this sometimes gives a great deal of trouble.

occasionally the wound becomes coated over with phosphates, and it may require to be washed out.

The diet should be simple but good. The question of stimulants must be determined by the habits of the patient and the condition of the pulse. The bowels may be opened on the third or fourth day by a gentle aperient, aided by an enema; and as soon as the wound is closing in and there is no further risk of hæmorrhage, the patient should be allowed to sit up on a chair.

ACCIDENTS

1. *Hæmorrhage.*—The transverse perinæal and external hæmorrhoidal arteries are rarely of consequence; if they continue bleeding, pressure-forceps may be placed upon them until the end of the operation. The artery to the bulb may be wounded either from its taking an abnormal course, or from the incision being commenced too far forwards, but it seldom causes any difficulty. Sometimes the bulb itself is injured in the same way. Profuse arterial hæmorrhage occasionally comes from some deep-seated trunk, possibly the internal pudic, though this is very well guarded under the lip of the tuberosity; if the vessel cannot be found and tied, forcipressure, acupressure, or even digital compression by relays of dressers, must be kept up for twenty-four hours.

Venous hæmorrhage may be profuse at the time, or may come on later, and the blood may collect in the bladder and distend it before the occurrence is known. The coagula must be washed out, the bleeding checked by cold and exposure to air; and if this does not succeed, or if it recurs after a few hours, the wound must be plugged. The best instrument for this purpose is Buckston Browne's dilatable tampon—a central tube, so that the urine has free exit, surrounded with a soft india-rubber sac which can be introduced when collapsed, and distended with air or water. A flexible tube should be attached, to conduct the urine at once to a vessel beneath the bed; but it must be recollected that plugging the wound assists absorption from the surface and exerts very injurious pressure upon the soft tissues.

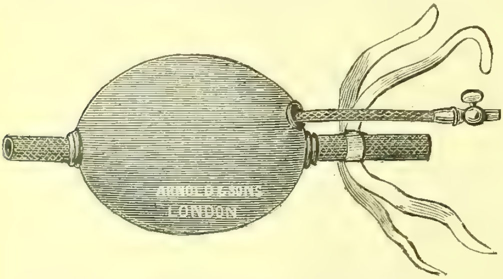

FIG. 432.—Buckston Browne's dilatable tampon.

2. *Wound of the rectum* may occur, especially in old people, in whom the lower end is often much dilated. It may be cut, owing to the knife not being sufficiently turned to one side, or it may slough from bruising. Generally, the opening closes of itself, but it may leave a fistula.

3. *The posterior wall of the bladder* has been punctured by the staff and by the knife leaving the groove and being carried in too far; and the urethra has been missed altogether, the knife passing by the side of it or behind it, and entering the bladder through the floor, or even behind the prostate.

4. *Tearing the urethra* across may occur in children. It arises from the deep incision being too small. The tissues are very delicate and easily give way: the bladder lies higher and is less fixed than it is later in life, and if

an attempt is made to force the finger down the urethra, it is very easy to tear it across and push everything onwards until a cavity that feels like the bladder is formed in the tissues at the neck. In some of these cases the deception has been increased by the stone being felt through the wall. If the accident is recognised in time, the finger should be withdrawn, and the knife carefully pushed along the groove until the bladder is really opened; but if the bladder is pushed off the staff so far that it cannot be brought down again, either the operation must be abandoned, or, as this is practically fatal, the suprapubic operation must be performed, the stone extracted, and a catheter passed through the orifice of the urethra from the interior into the perinæal wound.

To avoid this Heath recommends that, instead of trying to pass the finger along the staff, a director should be introduced into the bladder first, the staff withdrawn, and the finger then gently worked along the upper surface of the director. In other cases a pair of polypus-forceps may be introduced to dilate the urethra; but whatever plan is adopted, if there is much resistance, it is wiser to remove the finger and enlarge the incision.

The **prognosis** in lateral lithotomy depends upon:

1. *Age.*—In children it is wonderfully successful, a series of seventy and eighty cases without a death having been published. As years advance it becomes steadily more and more fatal.

2. *The size of the calculus.*—Up to an inch in diameter this is not material; over this, the mortality increases rapidly, and in very large calculi the operation is exceedingly dangerous.

3. *The state of the kidneys.*—This is the most important of the three. Most of the fatal cases may be traced to urinary fever with suppression, or to diffuse inflammation and exhaustion, consequent on renal disease.

Causes of death. 1. *Septicæmia.*—All the structures around the wound are torn and crushed; there is a certain amount of decomposing urine, and the tissues, if the kidneys are diseased, break down and slough at once. It generally begins about the second or third day; there may be a rigor with high fever, acute cellulitis, and distension of the abdomen; or the beginning may be insidious with little or no pain, but with dryness of the mouth and tongue, hiccough, and extreme prostration. It is nearly always fatal, but recovery with the formation of pelvic abscesses has been known.

2. *Urinary fever* may be acute and fatal within forty-eight hours from suppression of urine; more often it is chronic, and associated in such a way with septicæmia that it is impossible to assign to each its share. It rarely occurs when the kidneys are sound, but it is a common cause of death where they are only just able to hold their own, as in old cases of calculous disease and chronic cystitis. Suppurative pyelonephritis sets in from extension of the inflammation up the ureters; multiple abscesses form in the cortex; the secretion of urine becomes still further diminished, and the patient dies with symptoms of low fever and prostration.

3. *Extravasation of urine* into the cellular tissue at the base of the bladder, owing to the neck having been laid open and the rectovesical fascia divided. Brodie saved one case in which this had occurred by laying the whole perinæum open into the rectum. Usually it is fatal within the first few days from acute peritonitis.

4. *Hæmorrhage*, not so much from the loss of blood at the time as from the weakened state in which the patient is left.

5. *Phlebitis and pyæmia.*

6. *Peritonitis* from wound of the posterior wall of the bladder, sloughing of a sacculus, or extension from the cellular tissue.

7. *Shock and exhaustion.*

Difficulties may arise in lateral lithotomy either from anatomical causes, or from the size, position, and shape of the calculus. The former include false passages in the urethra, enlargement of the prostate, unusual depth of perinæum, contraction of the pelvis from rickets, and such occasional obstacles as tumours growing from the bones, and anchylosis of the hip-joint. These may usually be overcome by the exercise of a certain amount of ingenuity. The size and shape of the stone may, however, be such as to render the operation impracticable. It is difficult to say what size of stone has not been removed through a lateral incision: but at the present time no one would willingly attempt the extraction of one two inches in diameter, and it is better to adopt other methods for all over an inch. The position of the stone is scarcely less important. When it is deeply embedded in a sac that it has worn for itself, it may be dislodged either by the finger in the rectum, or by inserting the nail beneath it, and gradually working it out, or even by very carefully notching the edges of the sphincter-like ring that holds it fixed; and this, it must be admitted, cannot be done by lithotrity; but when the stone is lying in a large thin-walled sacculus, the orifice of which is at some distance from the neck, and very likely is only sufficiently large to admit a quill-pen, it cannot be removed. If a small tube can be introduced through the perinæal wound, some relief may be obtained by draining the sacculus, but there is no means of extracting the stone.

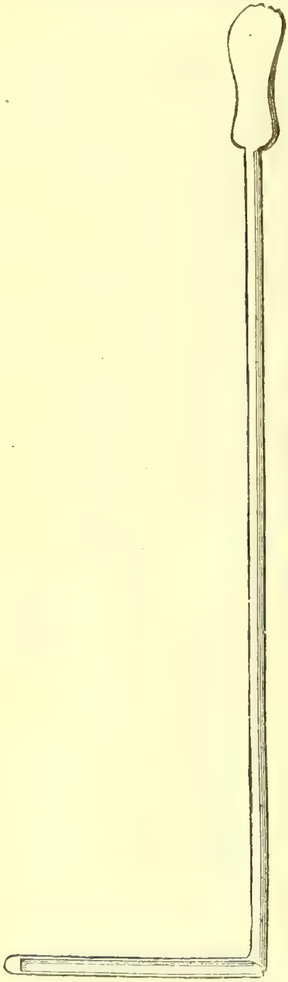
Fig. 433.—Angular staff.

Median lithotomy.—In this the deep incision extends only through the membranous portion of the urethra and the apex of the prostate.

The patient is prepared for operation in the same way, and placed in the same position, but the staff used is rectangular, so as to bring the apex of the prostate as near the surface as possible. The forefinger of the left hand is placed in the rectum, and either an incision made in the middle line, or a straight-backed bistoury, with the edge toward the pubes, pushed at once through the perinæum to the angle of the staff. Whichever plan is adopted, the incision must be exactly median, commencing below the bulb, stopping short of the rectum, and laying open the membranous part of the urethra and the commencement of the prostatic. A director is then passed along the groove into the bladder, the staff withdrawn, and the forefinger insinuated along the urethra, following the upper surface, because the roof is more firmly fixed than the floor, and there is less danger of tearing it across. In this way the prostate is gradually dilated, until the finger gains the interior of the bladder. There is a certain amount of bruising, and possibly rupture of the gland-tissue and muscular fibre beneath the mucous membrane; but, so far as the adult is concerned, there is no extensive laceration (a similar operation is often performed merely for exploration), and rupture of the capsule or of the rectovesical fascia is impossible. The operation is then completed in the ordinary manner.

Comparison of Lateral and Median Lithotomy

The chief advantages possessed by the median are—

(*a*) Less risk of hæmorrhage. Abnormal arteries cannot be divided, and the prostatic plexus is not opened.

(*b*) It is impossible to injure the rectovesical fascia. In the lateral operation the knife runs along the groove of the staff, cutting the prostate and the neck of the bladder: so long as the incision is only the depth of the blade, which is quite sufficient to allow the finger to pass into the bladder without forcing it in the least, the lateral true ligaments and the pelvic cellular tissue are entirely out of danger; but if the knife is not kept parallel to the staff, especially when the deepest part of the incision is being made, or if the surgeon allows his hand to drop too much, it is very easy to carry the incision right through the gland and the prostatic plexus. In the median operation this is impossible; the incision goes no farther than the apex of the prostate, and the finger cannot tear the fascia.

(*c*) After the operation the urine very soon ceases to flow out of the wound, and the patient is saved much discomfort.

The disadvantages are—

(*a*) Want of space, not only for the superficial, but for the deep incision; so that a calculus more than an inch in diameter cannot be extracted. To obviate this Harrison recommends that an incision should be made with a probe-pointed bistoury along the floor of the prostatic urethra, from within outwards; and that then the two sides of the prostate should be torn asunder by the pressure of the index finger.

(*b*) In children particularly there is the danger of tearing the urethra across.

(*c*) The bulb and the rectum are both more likely to be wounded.

Median lithotomy can only be performed when the calculus is small, and is seldom selected unless there is some condition which either precludes crushing, or renders it inadvisable. The following are the chief:—

1. Dense cartilaginous stricture, involving the membranous or the posterior portion of the bulbous part of the urethra. This may be incised at the same time.

2. Enlargement of the prostate, in which it is thought that either a portion of the gland may be removed with advantage, or the post-prostatic pouch drained.

3. When there is a foreign body of peculiar shape.

4. When there is a number of calculi, too large to come away in an ordinary evacuating tube, and too many to be crushed.

5. When there is a calculus or a fragment impacted at the neck of the

bladder, or in the prostate, or in the orifice of one of the ureters, endangering the safety of the kidney.

6. As an adjunct to lithotrity, after the stone has been crushed, where it is desired to evacuate the fragments at once, or to drain the bladder.

Suprapubic Lithotomy

In this the bladder is opened over the pubic symphysis, below the peritoneum.

When the bladder is empty the fold of the peritoneum lies below the upper border of the pubic symphysis ; in moderate distension it rises to the same level, and in some people it may be half, or even three-quarters of an inch above, but it is only in cases of chronic retention that the space is of any size. According to Garson this is mainly due to the bladder stretching backwards into the hollow of the sacrum and compressing the rectum, instead of rising up out of the pelvis ; and if this is prevented by filling the intestine to a very moderate extent, the fold of the peritoneum may be raised (especially in fat people) sufficiently for all surgical purposes. There is no strain upon the wall of the bladder; its anterior surface is well exposed; and the floor is raised and fixed, so that it is much more easy to introduce sutures if they are required.

In children the fold of peritoneum is higher; when the bladder is moderately full it is nearly always well above the level of the bone; in distension there may be two inches, and even more.

The preparation of the patient is the same, but the position is the ordinary recumbent one, with the hips slightly flexed. A very thin cylindrical rubber bag, made without seams, and capable of holding twelve ounces, is introduced into the rectum well above the sphincter, and connected with an irrigating can filled with warm water. Distension in this way is more equable than with a syringe, and the tube can be clamped or unclamped at any time. Ten ounces are usually ample, even in an old person ; and less than this is advisable for a young adult ; the mucous membrane of the rectum has been severely injured on several occasions by bags of unsuitable shape or size. A soft catheter should then be passed, the bladder washed out with a warm antiseptic solution, and the end of the catheter connected by a flexible tube with a vessel filled with the same. By raising or lowering this, as occasion requires, the bladder may be filled to any desired extent, or emptied, without the necessity of tying anything round the penis. This method of distension is much to be preferred, both in the case of the rectum and bladder. It is gradual and perfectly even ; it can be regulated to a nicety, and can be relieved at once by lowering the vessel.

The pubes must be shaved, and an incision three or four inches in length made exactly in the middle line, commencing just below the upper margin of the symphysis. The sheath of the rectus is exposed first, and carefully divided upon a director ; then the layer of the transversalis fascia that bounds the prevesical space in front : the posterior one should prevent the peritoneum being seen, but if it comes into view it must be pushed up out of the way with the finger. In the case of very large calculi it may be necessary to divide the tendon on either side, but this should be done as little as possible.

If the vessel connected with the catheter is raised a little, the bladder slowly presents itself, covered over with a layer of soft, delicate fat (sometimes of considerable thickness), containing numerous tortuous veins. It is essential to interfere with this as little as possible; the handle of a scalpel, or an ivory separator, as Thompson recommends, may be used to push it to one side; one of the chief risks is the infiltration of urine, and this is almost sure to follow if there is any rough handling or hæmorrhage. In most cases there are two large veins running down the anterior surface of the bladder in a vertical direction; and the greatest care is needed to avoid not only these but the smaller ones near the neck.

One way of securing the bladder, so that it does not collapse when opened, is to pass two sutures through the muscular coat, one on either side; but a sharp hook or toothed forceps is usually preferred. The opening itself should be made with a scalpel (the edge pointing towards the pubes) in the middle line between the veins, and it should be large enough to admit the finger. The calculus must be dealt with according to its size and position. Sometimes it can be extracted by the finger and a scoop, or with two forefingers; in other cases polypus-forceps, or lithotomy-forceps, may be used to lay hold of it; even small midwifery-forceps have been employed; and in one instance it was necessary to break up the calculus with chisel and mallet. One disadvantage of rectal distension is that the stone, owing to the way in which the centre of the floor of the bladder is elevated, is apt to roll down to the sides. This, however, is of little importance, as the whole interior can be easily explored.

The treatment of the wound must be guided by the condition of the urine and of the walls of the bladder. In children and young adults, if the kidneys are sound, and the muscular coat fairly healthy and not much bruised, an attempt should be made to secure union by the first intention. Two series of sutures may be used—one through the muscular coat to bring the edges together; the other, Lembert's, outside this; but neither should touch the mucous membrane, and the latter should extend not only the whole length of the wound, but for a little distance beyond at either end. Either silk or chromic catgut may be used. In any case the sutures must not be more than an eighth of an inch apart, or when the bladder becomes distended leakage will take place between them. Even if they do give way after twenty-four or forty-eight hours, the risk of urinary extravasation is by that time much diminished, and in a fair proportion of the cases the wound has healed up at once. If, however, the walls are thinned or fasciculated, if they have been bruised, if the urine is ammoniacal, or the kidneys diseased, union by the first intention is so problematical that it is wiser not to try. The wound in the bladder should be left entirely open, the abdominal one, if it is very long, being closed, so far at least as the upper extremity is concerned.

If the wound of the bladder is sutured, morphia is usually advisable. Suppositories may be used, but it is better injected directly into the tissues over the pubes. If there is any doubt about the condition of the sutures a catheter may be passed as often as required; with cocaine there is rarely any objection, but, especially in the case of children, it should be avoided if possible. Tying a catheter in is not merely useless, but a constant source of irritation; and draining through the perinæum, though it may be sometimes advisable to prevent decomposition after the removal of tumours of the bladder, is rarely needed in lithotomy.

If the wound is not secured, an attempt must be made to keep the bladder as dry as possible. In his earlier cases Thompson recommended that the patient should simply lie on his side, changing from one to the other every six hours, so as to prevent excoriation. Trendelenburg tried the prone position, but this is scarcely practicable in the cases which require it most. The simplest plan is to introduce a full-sized tube, and thread it with loosely-packed lamp-wick for about a foot of its length so that it will act as a siphon. If this fails, an apparatus like a Higginson's syringe may be attached to it by a side branch, and the contents aspirated at frequent intervals either by the patient or the nurse. Greig Smith does not consider a drainage-tube necessary if absorbent dressings are used and changed at frequent intervals; the bladder is kept empty by the pressure of the viscera above it.

Compared with the perinæal methods, the accidents that may occur in the course of suprapubic lithotomy are exceedingly few, and easily avoided. The rectum and bladder have been ruptured from excessive dilatation, and inflammation of the mucous membrane of the former has been caused by the pressure. The peritoneum has been opened, so that the operation had to be delayed: and free hæmorrhage may occur from the prevesical plexus. This, however, is important rather from the facility that it gives to subsequent suppuration and extravasation of urine than from actual loss of blood.

Causes of death.—In children this operation is as successful as lateral lithotomy. In adults the comparison is hardly fair, as many of the cases were such that the lateral operation was impossible.

Suppurative pyelonephritis, with partial suppression, is the most common. It generally proves fatal in the course of a few days, with low muttering delirium and extreme prostration.

Pericystitis, extending into the cavity of the pelvis and setting up pelvic cellulitis and peritonitis, may occur from injury to the soft tissues around the bladder, or from extravasation of urine. Its course and severity depend largely upon the condition of the kidneys; in children, for instance, it very rarely occurs.

Besides these, death may occur from shock, exhaustion, pyæmia, or other sequelæ common to all operations in such conditions.

Choice of Method

Three things have to be taken into consideration in selecting a method; the patient, the urinary organs, and the calculus.

1. *The patient.*—Under six years of age, crushing is not advisable. It has been done in younger patients, and occasionally the urethra is sufficiently capacious; but this is exceptional.

Between six and puberty, crushing and cutting (for all moderate-sized stones) are equally successful. Unless there is some other condition, the choice is perfectly open. After puberty, so far as years alone are concerned, there is no question that the former is to be preferred.

2. *The urinary organs. The urethra.*—The presence of a stricture or false passage does not preclude lithotrity, but it is an objection; if there is much inflammatory exudation around, suppuration and urinary abscess are not unlikely. Enlargement of the prostate in the same way, so long as it is moderate, does not prevent crushing, though it renders it difficult; but when

it is excessive, or very irregular, with a deep post-prostatic pouch, the suprapubic method is better.

The state of the bladder.—Atony of itself does not prevent lithotrity, or make the operation difficult ; the trouble comes afterwards from the constant washing out that is required. It must be remembered that sometimes it is advisable, for the sake of the atony, to make an opening in the bladder and drain it thoroughly.

The same may be said of cystitis. If it is slight and due to the calculus, it will be made perhaps a little more severe by the crushing, but, the cause being removed, the inflammation soon subsides. When, however, the cystitis has already lasted some time, and the walls are irregular or the urine ammoniacal, it is necessary to take other things into consideration. If the kidneys are sound (which they seldom are) and the urethra tolerant, the calculus may be crushed, and the bladder washed out periodically, to clear away the decomposing mucus from the walls and stop the fermentation ; but in many of these cases it is wiser to drain the bladder through an opening in the perinæum, and, if this is done, it is as well at the same time to extract either the calculus itself, if it is small, or the fragments into which it has been broken by a few minutes' crushing. This combination of crushing with the median operation is exceedingly useful ; the operation is not a long one, the shock is not severe, the bladder can be thoroughly emptied, and it enjoys perfect rest afterwards, the urine being drained off directly by means of a flexible tube carried outside the bed.

If the presence of sacculi can be diagnosed, crushing should not be attempted. Most of the cases of peritonitis are caused in this way.

The state of the kidneys.—When these are diseased it is still a question whether lithotomy or lithotrity is the worse. Much depends upon the calculus, but probably a great deal more upon the operator. If the stone is only of moderate size and soft, and if the crushing is done by a practised hand, rapidly and gently, with the minimum of manipulation and without any bruising, the risk is very much less than in any cutting operation ; but, on the other hand, if the stone is of unusual size or hardness, if the condition of the bladder is such that fragments are likely to remain behind in the mucus, or to require a great deal of manipulation, it is probable that the suprapubic or the combined operation is the better, as inflicting less injury.

3. *The calculus.*—Calculi have been crushed up to four ounces in weight, but such are exceptional. As a rule, an oxalate of lime one over an inch in diameter, or one of uric acid over an inch and a half, is nearly as much as can be accomplished. For larger ones (unless they are very soft) the suprapubic operation alone is suitable. Besides the size of the calculus, however, its position, especially if it is fixed, and its shape, are of importance in determining the method of operation.

Sometimes there are other considerations present, which prevent either crushing or cutting and limit the choice, as, for example, deformity of the pelvis, tumours growing from the pubic bones, or from the prostate and bladder, anchylosis of the hip-joint, &c.

Lithotrity, therefore, is not suited to children under six years of age ; for calculi over a certain size (depending upon their composition), encysted stone, or in cases of dense stricture. Whether it should be preferred to other methods in cystitis, atony, great enlargement of the prostate and disease of the kidneys (all of which frequently occur together), depends chiefly upon the operator. The stigma from which it suffers is the frequency of recurrence, even as much as one in seven or eight, in the most practised hands.

As regards lithotomy, the suprapubic method is probably the easiest and the least dangerous in the hands of most operators, but it must still be regarded as to a certain extent the fashion of the day, and therefore upon its trial. For calculi over an inch and a half in diameter it is the only method, unless the stone is first broken into a few fragments, and extracted by the median. Recovery is more slow after it than after the lateral or the median (except in children); it is almost as liable to be followed by urinary fistula; and drainage is certainly a difficulty, especially if there is cystitis; but there is no important structure near that can be injured if reasonable care is used, the space is less limited, there is no danger of hæmorrhage, the incisions are more easy, the removal of the calculus is not attended with such difficulty, and the interior of the bladder can be explored more thoroughly. Sometimes other conditions, such as adhering masses of phosphates, can be dealt with at the same time.

Calculus in the Female

The anatomical conditions of the female bladder are such that calculus is much more rare, and is much easier of extraction than in the male; moreover, in them, the extreme form of cystitis, with fasciculated and sacculated walls, which results from stricture or enlarged prostate, and is always attended by disease of the kidneys, is practically unknown.

In adults the urethra may be dilated so as to admit the forefinger without risk of incontinence, so that small calculi can be extracted directly. If they are too large for this, a lithotrite may be used to break them up sufficiently; if larger still—and they have been known to be of enormous size—they may be extracted either through the vagina or by the suprapubic method. The latter is perhaps to be preferred, as the former, even when the incision is sewn up at once, exposes the patient to the risk of vesico-vaginal fistula. In children, in whom the sexual organs are not developed, and who seem not to suffer from infiltration of urine to the same extent as adults, the suprapubic is certainly the better method.

TUMOURS OF THE BLADDER

Tumours of the bladder have a peculiar tendency to assume a papillomatous character, even when they are malignant. There are no papillæ in the mucous membrane, but it must be remembered that the bladder and allantois are developed in connection with each other, and that the fœtal villi are partially dependent upon the latter. There is a very close resemblance in external appearance and even in structure between some forms of vesical papilloma and the tufts that are found on the placenta.

Papilloma

In many cases the tumour is composed of nothing but these villi. When the bladder is empty there is a rounded, red, vascular mass lying on the mucous membrane, springing evidently from its superficial layers, and freely movable on the subjacent tissue. As soon as it is placed in water a number of delicate hair-like processes float out from it in all directions like the tentacles of a sea-anemone. Each contains a loop of a vessel, and outside this a delicate basement membrane upon which rests the columnar epithelium. In many there is no fibrous tissue at all: in the larger there may be a few threads running by the side of and surrounding the blood-vessels. These tumours are known as fimbriated papillomata; usually they are single and sessile, growing near the trigone, but they may be multiple and pedunculated. In exceptional cases the whole interior of the bladder is covered over with a shaggy coat.

FIBRO-PAPILLOMA

In these there is a greater amount of fibrous tissue; they are denser and firmer than the former, but they still belong mainly to the mucous membrane. In external appearance they are very similar, but the villi are usually shorter and less characteristic.

FIBROMA

Tumours consisting of fibrous tissue only are occasionally found in connection with the submucous coat. Usually they project as polypoid growths, with the unaltered mucous membrane stretched over them; but, as with all other vesical tumours, they are occasionally covered with villi. In some there is a certain amount of unstriped muscular tissue, so that they are really fibro-myomata; and pure myoma has been described. In others (fibro-myxoma) some of the fibrous part has become converted into mucous tissue.

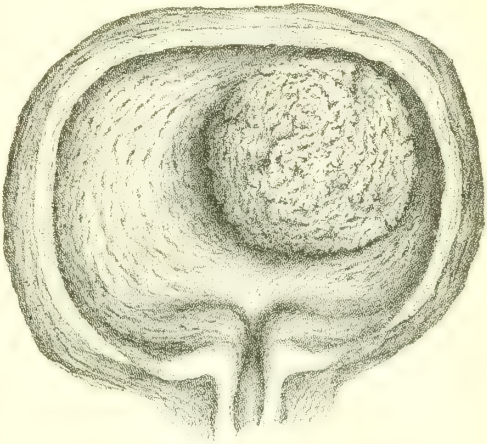

FIG. 434.—Fibro-papilloma of the bladder.

Sarcomata are more rare. In external appearance they resemble fibro-papillomata, but the fibrous tissue in the interior is replaced by sarcomatous elements, and their growth is much more rapid. In some instances, in which fibro-papillomata have recurred after removal, the secondary growths were softer and sprang up more quickly than the original, as if the fibrous part was giving way to a growth of less perfect type. In a few cases round-celled, spindle-celled, and even chondrifying sarcomata have been found.

MUCOUS POLYPI

Outgrowths from the mucous membrane, resembling those that are met with in the nasal passages and in the rectum, are not uncommon, especially in children. Often they are multiple, and the pedicles occasionally become stretched to such an extent that in females they may even protrude at the meatus.

CARCINOMA

Scirrhus and encephaloid are rare. Epithelioma, on the other hand, is the most common of all tumours. It is usually found after middle life, and it may occur at any part of the bladder. Nothing is known with regard to its cause; there is no reason to connect it with the irritation of calculi, catheters, or anything else. In general the tumour is single, but sometimes there is more than one, and occasionally they are very numerous. In a few instances, in which the growths have been on opposite sides, it would seem as if the secondary ones had originated by a process of infection from the first. When there is a perinæal wound it is not uncommon for the mass to protrude and fungate, as if it had spread along the granulation tissue; but this may admit of other explanations.

At first the mucous membrane is smooth and unaltered, merely raised and vascular; but ulceration very soon sets in, and, the tumour being as it were macerated in the urine, the surface soon becomes exceedingly irregular and covered over with sloughing shreds of tissue. The growth itself is never encapsuled or freely movable on the deeper strata; it infiltrates the submucous and muscular coats with great rapidity, and spreads from them to the surrounding organs. Sometimes the converse is the case, and the bladder becomes secondarily involved from malignant disease of the uterus or rectum.

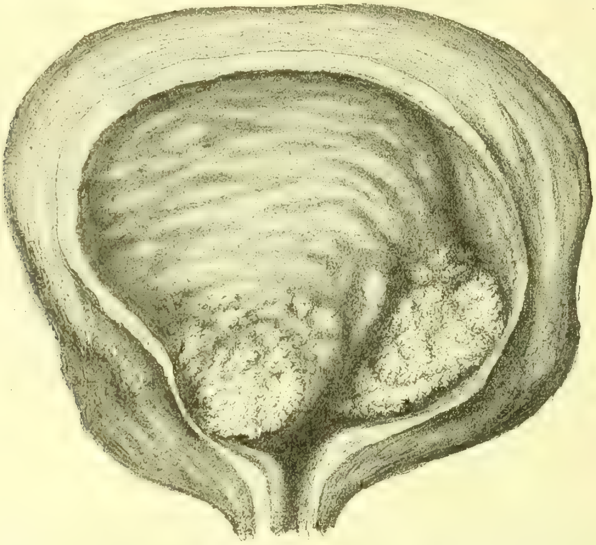

FIG. 435.—Epithelioma of the bladder. Two apparently distinct masses opposite to each other.

General symptoms of tumours of the bladder.—Hæmorrhage and irritability of the bladder, sometimes amounting to cystitis, are the most prominent.

The former varies in amount and frequency according to the nature of the growth. In papillomata it is usually profuse, pouring out from the delicate villi, and very irregular in occurrence. Often the first thing noticed is a sudden gush of bright blood following micturition, and then there may be an interval of months. In carcinoma, on the other hand, hæmorrhage is usually preceded by increased frequency of micturition and dysuria, and the amount of blood, though small, is much more constant. In the later stages the difference becomes still more marked ; with papillomata there is discomfort, sometimes pain ; severe cystitis may occur as a complication ; the urine may even become ammoniacal and the tumour crusted over with a layer of phosphates ; but this is as nothing compared with the severity of the suffering in carcinoma, especially when ulceration sets in. Decomposition of the urine nearly always occurs ; the pain is excruciating, radiating all over the body ; the desire to pass water is unceasing, and gives no relief ; there is constant burning at the neck of the bladder, rest or sleep is impossible, and the strength rapidly gives way. All these symptoms are intensely aggravated when the growth is near the orifice of the ureters, so that renal troubles are present in addition.

The **diagnosis** must be made from : (*a*) the age of the patient (papillomata and polypi may occur at any time of life, though they are more common in the young—carcinoma probably never before forty) ; (*b*) the character and order of the symptoms ; (*c*) examination of the urine ; and (*d*) exploration of the bladder.

Besides the blood that is present in the urine and the increased amount of mucus caused by the cystitis, portions of these growths may occasionally be found and their nature identified under the microscope. Villi are unmistakable ; cancer-cells when isolated cannot be distinguished from the normal epithelium of the bladder, but occasionally there are cell-nests or small sloughing fragments of the growth. It is convenient for this purpose to allow the urine to settle for some hours in a tall conical glass which can be tapped from the bottom without the introduction of a pipette. In suspected cases, when this fails, an attempt may be made to obtain some of the fragments by washing out the bladder with a large-eyed catheter, the edges of the opening being rather sharp. If the urine is allowed to discharge itself suddenly, projecting portions of the growth can sometimes be entangled and brought away. Sir H. Thompson on one occasion extracted a fragment with a small lithotrite.

Exact information, particularly as to site, can only be obtained by examination of the bladder itself. The sound is of very little use until the disease is very far advanced ; a soft papillomatous growth cannot be detected by the touch, and though profuse hæmaturia following a carefully conducted examination is very suggestive, it is nothing more unless a fragment of the growth is found. It is probably in this that the cystoscope will show its value most (fig. 436). It consists of a hollow shaft, of as large a calibre as the urethra will take, with a short beak set on the end at an angle. At the end of the beak is a miniature incandescent electric lamp ; in one form of the instrument this is unprotected, in another it is covered in by a cap of metal with a rock-crystal window. At the junction of the beak and the shaft is a second window, closed by a prism, so that the rays of light entering it are reflected down the tube towards the eye of the observer. In the tube are lenses for the purpose of magnifying the image.

For the anterior surface of the bladder (when the beak is turned up) the two windows are on the concavity ; for the trigone and base, on the convexity of the curve. The current is turned on and off as required by means of a small key in the circular handle.

Burnt in air the cap of the instrument becomes exceedingly hot, in water (and urine) it remains perfectly cool, and so long as it is prevented touching the mucous membrane it causes no inconvenience. For this reason the bladder is partly filled with a clear fluid, and the current is not turned on until the instrument is in position. For women a larger tube may be employed.

There is no doubt as to the value of this instrument in distinguishing the site from which a tumour grows; but it must be recollected that it only allows a very minute portion of the bladder-wall to be seen at one time, and that even with the naked eye, when the bladder is laid open, it is not always possible to be certain as to the clinical features of a minute growth. Natural rugosities of the bladder-wall, low villous growths of an inflammatory character, such as are not unfrequently met with in cases of calculi, prolapse of the ureter (fig. 443), and many other conditions, present a closely similar appearance.

Examination *per rectum* or *per vaginam* rarely reveals much. Sometimes, in the case of carcinoma, a certain amount of induration may be detected; the tissues seem matted together when pressure is made upon them; but for this to occur the growth must be so far advanced as to preclude all hope of removal. In women the interior of the bladder may be explored with the finger under an anæsthetic.

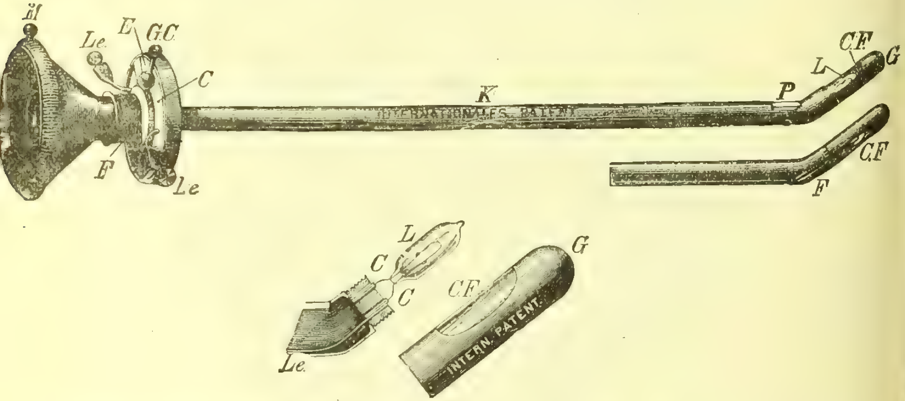

FIG. 436.—Leiter's cystoscope (Schall's catalogue), showing two ends, lamp, and cap.

Treatment.—This must be guided by the nature of the growth. Simple tumours should be removed as soon as possible; if left, the patient merely becomes exhausted by hæmorrhage and cystitis. Provided the growth is pedunculated and accessible, the operation is one of comparative ease; when these conditions are reversed it may be excessively difficult, and in some instances it has been impossible. In malignant disease it is questionable whether it should be attempted. The cystoscope may reveal the existence of an epithelial growth long before it could be detected in other ways; but even then the hope is very slight, although portions of the bladder-wall have been removed on several occasions, with recovery from the effects of the operation, for a time at least.

In men the bladder may be entered either above the pubes or through the perinæum. The latter is the simpler, and affords much better drainage, so that there is less risk of septic decomposition and absorption. In young subjects, too, the whole of the interior can be brought within reach of the finger, by pressure over the pubes. If, however, the prostate is enlarged, or the pelvis contracted, or, if the perinæum is thick and rigid, this is scarcely practicable; and pressure on the abdomen has the grave disadvantage of inverting the bladder, so that, before now, portions of the wall have been excised by mistake, and the peritoneal cavity opened. On the other hand, with a suprapubic opening, the whole of the interior can be easily reached with the finger; and, what is very important (for the cystoscope is of no use in an operation, owing to hæmorrhage), a great deal of it can be seen.

Suprapubic Cystotomy

The preliminary steps are the same as in suprapubic lithotomy. The bladder is carefully washed out with an antiseptic; the rectum distended with a rubber bag connected with a receiver; and a second receiver attached to the catheter in the bladder. The incision is the same; the sheath of the recti opened in the same way; and the same precautions taken in dealing with the loose cellular tissue and the large veins in the prevesical space. As soon as they come into view, the receiver connected with the bladder is slowly raised, so that it can unfold itself and roll the fold of peritoneum up out of the way.

A hook, or two sutures, should be inserted into the wall of the bladder to prevent its collapsing when the opening is made. This is best done with a sharp bistoury, the incision being of sufficient size to admit the forefinger without stretching.

Various methods may be employed for the removal of the growth, according to its nature, situation, and the extent of its attachment. Small vascular excrescences covering a large portion of the wall, and bleeding at the slightest touch, should be scraped off with the finger-nail, or, as Bryant has suggested, with a dry and rather rough sponge. Polypi with a distinct pedicle may either be removed in the same way or twisted off with two pairs of forceps, care being taken that the neck only is grasped, and that only torsion, not traction, is used; or with a snare. The galvano-cautery has been employed, but it does not present any material advantage. Soft, papillomatous growths may be treated in the same fashion, but Thompson's bladder-forceps, in which the crushing edge is protected by a free margin projecting beyond, so that when the neck of the growth is caught the wall of the bladder is pushed away, are more safe. In one or two instances catgut ligatures have been placed round the base, and the growth removed with scissors. Whatever method is employed, the whole tumour should be excised as far as it possibly can be; any portion that is left behind is liable to bleed, and, from the bruising it has undergone, to slough and become septic. Hæmorrhage must be stopped, and all the blood cleared away, by washing out the bladder with water of the temperature of 120° F., and touching any points that keep on oozing with some styptic.

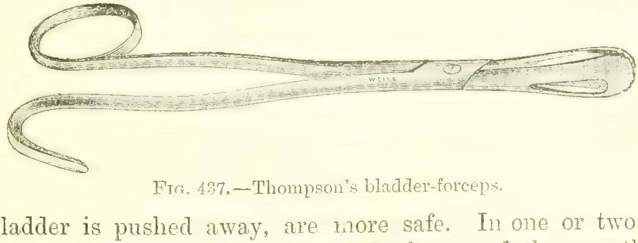

FIG. 437.—Thompson's bladder-forceps.

The treatment of the bladder depends upon the condition of the urine, and upon the state of its walls. In young subjects, in whom the urine is healthy and the tissues not bruised, the opening, which contracts at once, should be secured by passing sutures after Lembert's plan, through the muscular coat only, or by using a double series, as in rupture of the bladder, in the hope of obtaining union by the first intention ; and the external wound should be treated in the same way, a large drainage-tube being placed in the lower angle behind the pubes. If, however, the urine is septic, or the walls of the bladder thickened from chronic inflammation, or if they are much bruised in the course of the operation, the wound is better left open, with a drainage-tube as described in suprapubic lithotomy. A few sutures may be placed in the superficial wound, if it is of any length, but only at its upper end. If the bladder is accurately sutured, it may not be necessary to pass a catheter at all ; but, in many cases, the urine requires to be drawn off with a soft instrument, three or four times a day. With cocaine, the process is almost painless. If septic decomposition is feared, especially if the urine was alkaline before the operation, or if a portion of the growth was left behind, or if the bleeding could not be completely stayed, the urethra should be opened in the perinæum, and the bladder drained thoroughly. The increased risk is very slight in comparison with the comfort and security against septic absorption that it ensures.

Perinæal Cystotomy

Even when the conditions already mentioned are favourable, this is only suitable for tumours in the immediate neighbourhood of the trigone, and for soft, distinctly pedunculated growths springing from other parts. The incisions are the same as for exploring or draining the bladder. Everything must be done by the sense of touch ; the exact position and direction of the neck must be made out with the finger, and then either the loop of a snare passed over it, or a pair of forceps introduced to seize it. The great merit of this operation consists in the perfect drainage that it affords afterwards, but it is only suitable for growths that can be scraped away at once with the finger-nail, or those that are so placed that they can be pinched or twisted off with forceps, without the wall of the bladder running any risk.

In women, tumours of the bladder may be removed either *supra pubes* or through the urethra. The steps of the former operation are the same as those described already ; the pressure of the rectal bag upon the urethra is generally sufficient to close it, so that a sufficient quantity of fluid can be injected. In the latter it is not advisable to rely merely upon dilatation ; incontinence of urine, partial more often than complete, has been known to follow exploration of the bladder with the finger only ; and the repeated introduction of instruments, and their manipulation when tightly grasped, would almost certainly end in this. It is much better to divide the outer two-thirds of the urethra in the middle line with a pair of scissors, and stretch the internal orifice. After the operation is finished, one or two sutures may be used to bring the cut surfaces together again. Care must be taken not to mistake inversion of the bladder and prolapse through the urethra for a polypus.

In malignant disease of the bladder, and in cases of simple growths that are too extensive to admit of removal, much may be done to relieve the patient's sufferings. If cystitis sets in, the baldder should be carefully washed out with a solution of corrosive sublimate every day, to hold the decomposition in check; and if there is very much irritation, a solution containing half a grain of morphia may be left in afterwards. Morphia, too, may be given hypodermically, but a careful watch must be kept upon the condition of the kidneys. If the strangury becomes severe, the bladder may be drained through an opening in the perinæum. In most cases this gives great relief, and the progress of the growth is less rapid for a time; but sometimes, especially when it is situated near the neck of the bladder, the wound becomes infected and fungating masses project. It has been proposed to divert the ureters, and so relieve the bladder of its function altogether; but I am not aware of any instance in which this has been done for carcinoma, and patients suffering from this are rarely in a fit condition for such operations. Finally, if a communication forms between the bladder and the rectum, so that fæces pass into the urine, the distress is so great, especially in men, and the risk of nephritis so much increased, that colotomy should be performed.

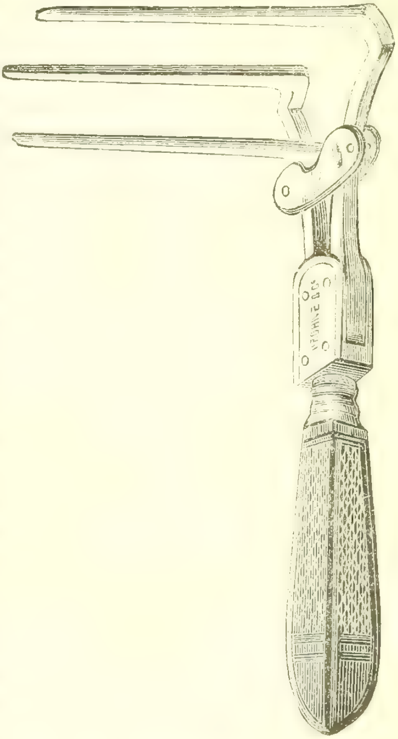

FIG. 438.—Dilator for female urethra.

Excision of a portion of the wall of the bladder has been practised in a few instances. In Sonnenburg's case, the upper two-thirds were removed with the peritoneum over it, the wound being closed by means of sutures, and the patient lived for six weeks. In Antal's, a tumour the size of a child's fist, with that part of the bladder-wall from which it sprang, was removed by a suprapubic incision, the peritoneum being stripped up without being opened. The vesical wound was closed, the abdominal one drained, and the patient recovered, and was able to hold his water for three or four hours.

CHAPTER XXII

DISEASES OF THE PROSTATE

ATROPHY OF THE PROSTATE

THIS has been described both in old age and in young adults; probably it is rather defective development at puberty. It does not give rise to any symptoms.

ENLARGEMENT OF THE PROSTATE

The prostate is liable to a peculiar form of enlargement which produces very serious effects upon the other urinary organs. It is rarely met with in men under fifty-five, for there are no symptoms until the size is very considerable; but it begins long before that, and I have known it well marked as early as forty-two. Some enlargement is present in about one-third of those who reach middle life, but it is only in a small proportion of these that there is any interference with the working of the bladder.

Pathology.—The nature of the growth is not always the same. In some cases it is a true hypertrophy, all the tissues of the gland enlarging equally, and the normal shape is retained; but this is the exception. The fibrous and muscular elements generally form by far the larger portion; the acini may dilate and become cystic, but there is rarely much adenoid growth. Not unfrequently tumours, resembling the fibromyomata of the uterus, are found in the interior; they are round and hard, formed of concentric layers, lighter in colour than the tissues near them, and surrounded by a kind of capsule, so that they can often be shelled out. As a rule they consist mainly of fibrous tissue, with some unstriped muscular fibre; occasionally acini and ducts are present as well, and in a few instances they deserve the name of adenoma. They may be single, but more often multiple; in some cases they are as large as a walnut, in others so small that they can scarcely be seen, and they may be buried in the substance of the gland, or project on the exterior as distinct nodules. The size the prostate may attain under these conditions is enormous, and the shape most irregular. Sometimes the lateral lobes are enlarged equally, or one is in great excess over the other; sometimes the median grows out and projects under the mucous membrane of the bladder, until it hangs over the orifice like a valve; in other cases again the enlargement is towards the rectum. The effect on the prostatic urethra is equally variable; it may be merely stretched until it is four inches in length, or it may be so tortuous and displaced that an instrument can hardly pass through it. In a few very rare cases it has been held open in such a way as to cause true incontinence, the urine flowing away from the bladder as it entered, leaving it always empty; much more often the walls are firmly pressed together, so that on transverse section it takes the form of a narrow vertical slit lying between the dense and solid lateral lobes.

Changes in the bladder. 1. *The neck.*—Owing to the apex of the prostate being fixed by the triangular ligament, the orifice of the bladder, which

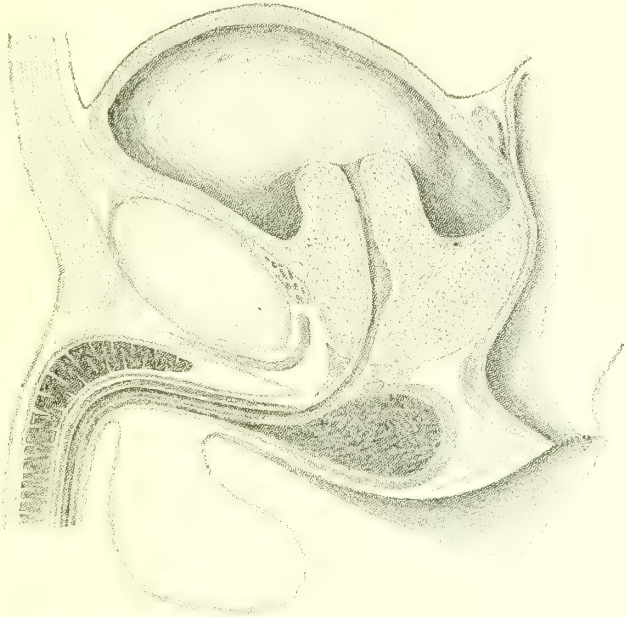

FIG. 439.—Enlargement of the whole prostate, with the formation of ante- and post-prostatic pouches.

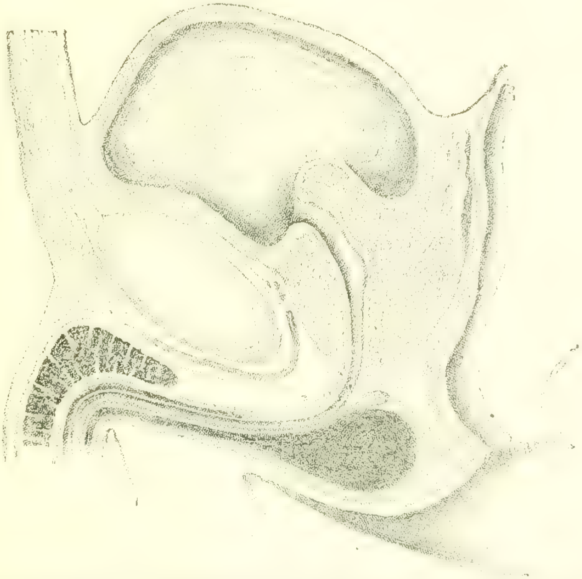

FIG. 440.—Enlargement of median lobe of prostate, showing its valve-like action.

normally is the lowest point when the body is erect, becomes displaced. If the elongation is uniform it is simply raised, so that the bladder drops as it were into a pouch in front and behind (fig. 439). More frequently, owing to the greater amount of the growth behind, it is not only raised, but tilted forwards so that it faces towards the pubes (fig. 440), and instead of the mucous surface shelving smoothly down to the urethra, the margins of the orifice are raised up into irregular lips and bosses. The anterior pouch is never very large, unless a calculus is impacted in it; the posterior, on the other hand, owing to the comparative thinness of the muscular coat above the interuretral bar, and the yielding nature of the tissues outside, may be expanded by the forcing of the urine down into it until it projects behind the prostate, between it and the rectum, and sometimes even reaches the perinæum.

2. *The fundus.*—The alteration in the shape of the neck soon produces changes in the rest. For mechanical reasons, the difficulty of emptying the bladder becomes greater. It may be the third lobe hanging over the orifice like a valve; or the increased length of the neck, forcing the bladder to act at a disadvantage, and increasing the resistance. If the obstruction is suddenly developed the muscular coat becomes stretched until it can no longer contract, and the bladder distended until it may reach as high as the umbilicus. If, on the other hand, it is slow and gradual, and if the neck of the bladder becomes irritable, so that the calls to micturition are more frequent than natural, the opposite effect is produced: the muscular coat, under the combined effect of increased work and increased frequency, becomes hypertrophied; the capacity diminishes, the walls grow thick and hard, and the bladder can neither collapse nor expand as it ought.

So long as the whole bladder is equally affected and there is no inflammation, the effect is similar to that produced by any other obstructing cause: the ureters and the pelvis of the kidney become dilated, the renal substance is absorbed, the interstitial connective tissue increases, the muscular coat of the bladder becomes fasciculated; and, in advanced cases, hernial protrusions of the mucous membrane make their way between the bands and enlarge into sacculi.

The effect, however, is very seldom uniform like this. Partly owing to the natural weakness of the posterior wall, partly to the direction of the pressure when the bladder contracts, the urine is driven down into the space behind the prostate, the tissues stretch more and more, and the post-prostatic pouch grows until it becomes a receptacle for urine, which is known as 'residual,' because it cannot be expelled by the bladder.

Unhappily this is not all. There is no reason in all this why inflammation should break out, and it may be years before it does, or perhaps it never may; but there is everything to favour it if it does. It may be due to an irritating condition of the urine such as is common in gout; or to some local cause (by far the most frequent is the passage of a catheter); if it once breaks out all the symptoms are intensely aggravated, the bladder becomes irritable, micturition is more frequent, the lining membrane is swollen and congested and pours out an abundance of mucus which collects behind the prostate; the walls grow thicker still, and the irritation spreads up the ureters, so that catarrhal pyelitis and interstitial nephritis soon follow.

If, in such a condition as this, decomposition of urea takes place, and the urine becomes ammoniacal, the effect is infinitely more severe. The patient is already broken down by suffering and want of rest; the tissues are badly nourished; the bladder is fasciculated, perhaps sacculated as well; the mucous membrane is in a state of chronic inflammation; the pelvis of the kidney is enlarged; its secreting power is diminished; a certain amount of urine, loaded with mucus, is constantly retained in the post-prostatic pouch, and though some of this may be changed when the bladder becomes full, the urine in the sacculi (if there are any) is not; if, in such a condition as this, decomposition of urea once sets in, every drop of urine as it falls from the ureters becomes changed at once, and the bladder in its already diseased state is filled with a most intense irritant which it cannot expel. The result is not difficult to imagine: phosphatic concretions form in all the depressions; the walls are covered with decomposing mucus mixed with salts of lime; the surface is eaten out by ulceration; the pus spreads in the submucous tissue, extending between the fasciculi of the muscular coat; the membrane that lines the ureters and pelvis of the kidneys is almost destroyed, and all the renal substance that the absorption and interstitial nephritis have left, is riddled with abscesses.

Etiology.—The cause of the hypertrophy is unknown, though it may be compared with the formation of fibroid tumours in the uterus. The muscular system of the prostate is a continuation of that of the bladder, but the gland itself is connected with the sexual rather than the urinary organs. It scarcely exists in infancy and does not attain any size until puberty; in adult life its muscular coat forms as it were a funnel-shaped prolongation of the neck of the bladder; a line of separation can be seen on section, but there is nothing on the mucous surface to point to it. For some reason, possibly connected with the condition of the sexual organs, it begins to enlarge as they begin to wane, and the larger and more complex it becomes the more it acquires the appearance of a distinct and independent structure.

Harrison considers the prostate essentially muscle, and holds that the presence of residual urine precedes, and is indirectly the cause of, the hypertrophy. For various reasons, in old age the floor of the bladder has a tendency to sink, so that there is difficulty in emptying it; the continued effort causes the prostate and the muscular band that passes between the ureters to increase until they coalesce and form a sufficiently powerful floor. The irregularities of growth, and the hypertrophy of the non-muscular tissues, are secondary to this. The effect, if this is the case, is most unfortunate, for the hypertrophy, which is intended to procure the expulsion of the residual urine, makes matters tenfold worse by the changes it induces in the shape of the neck.

With more probability it has been argued that the enlargement is the result of persistent congestion. It is well known that old men with enlarged prostates are subject to the most extraordinary libidinous desires, and it is usual to assign this as the cause. That they are connected is almost certain, but it is not impossible that the cause has been mistaken for the effect, and that the latent erotic desires are manifested because at that time of life the control that was formerly exercised over them has become feeble. Chronic congestion is certainly present in enlargement of the prostate in a degree that would not be suspected from post-mortem examination; and though this disease is met with in all classes, it is of some significance that it occurs most frequently in those who are of full or gouty habit, especially if they are compelled to lead sedentary lives.

The relation between atony of the bladder and enlargement of the prostate is another question. Harrison, as already mentioned, regards the former as the origin of the latter; the primary cause is the inability of the bladder to empty itself. Others consider that the two occur together as a result of senile degeneration; while others again believe the atony to be entirely the consequence of the obstruction, compensative hypertrophy failing from age. Whatever the primary cause may be, there is no doubt that, so far as the later stages are concerned, the last-mentioned view is the correct one.

Symptoms.—The symptoms directly due to the enlargement are so indefinite and gradual that in most cases the disease is already advanced before the patient thinks of applying for relief. Exceptionally, retention occurs at an early period.

Frequency of micturition is one of the first symptoms; different positions of the body, various kinds of movement, especially rising from the recumbent position, excite a desire to micturate at once, and the call must be obeyed. In the daytime it may not be severe, or perhaps is not much noticed; but, especially if much fluid is taken late in the evening, the patient has to get out of bed several times towards morning, or while dressing finds that he is constantly desiring to pass water. In other words, the muscular coat is beginning to fail, and though it may still be capable of emptying a bladder thoroughly when not too full, it cannot deal effectually with an accumulation; a certain amount only is expelled before it is tired out, then it must rest for a time; and the difficulty becomes greater every day, until at length a small but constantly increasing amount is left permanently as residual urine.

For the same reason the stream fails in strength; it is slow in coming and has no force—the urine flows away rather than is driven out; there is hesitation at the commencement, and the last few drops fall without control.

Slight hæmorrhage is not infrequent, especially when the call is urgent; occasionally it is rather profuse; obscure aches and pains are often felt in the loins or down the thighs; erections of the penis and sexual irritation may occur and be very annoying. The rectum becomes affected by the constant straining; prolapse or hæmorrhoids may follow; there is a teasing sense of fulness about the anus, and in advanced cases defæcation is very liable to take place simultaneously with micturition.

Retention may occur at any time. It may be complete, no drop escaping from the urethra; either the median lobe suddenly blocks the orifice like a valve, or the congestion becomes so great that the obstruction is too much for the weakened muscle. More often it is gradual; the residual urine increases, the strength of the bladder diminishes, and at length it becomes so full that it can contain no more—the urine flows out from it drop by drop as it enters from the ureters. This is *overflow*, and must be clearly distinguished from incontinence, in which the bladder is empty.

The other symptoms depend not so much upon the enlargement as upon its complications—cystitis and pyelonephritis. Even when the inflammation is slight the irritability of the bladder is most distressing; micturition is no sooner ended than the burning begins again; rest at night is impossible; the pain never ceases; the appetite is lost; the bowels are disordered; the health is broken down completely by the ceaseless suffering, and the patient becomes worn out and emaciated. But when the urine becomes ammoniacal and suppurative pyelonephritis is added to the rest, the results are infinitely more severe. The urine is most offensive, it is loaded with albumin and throws down a gelatinous deposit of pus mixed with blood and phosphates; the specific gravity is lowered, the quantity fails, suppression sets in more or less, and partly from this, partly from the constant suffering and the septic absorption from the ulcerated mucous membrane of the bladder, the constitution becomes utterly broken down. The temperature may not rise, sometimes it is even subnormal, but the tongue becomes dry and brown; the pulse small and quick; low muttering delirium sets in; the restlessness is extreme, the patient wants incessantly to get out of bed, the strength fails completely, and exhaustion or uræmia and coma speedily follow.

Diagnosis.—Enlargement of the prostate can only be proved by an examination of the urethra or rectum, or, better, the two together. If the rectum only is examined, the patient may either stand with the feet slightly separated and stoop forwards over the end of a sofa, or, more comfortably, lie on his side close to the edge of a firm couch with the knees drawn well up. The central portion of a healthy prostate is soft and yielding, the sides are more firm, but shade off gradually into the tissues around; when it is enlarged it feels dense and resistant, or the consistence is uneven, and the outline more sharply marked and irregular. In extreme cases a shapeless mass projects into the rectum, extending far beyond the reach of the finger, both above and on either side.

The degree of obstruction can only be ascertained by passing a catheter; if the growth extends towards the rectum, the power of the bladder may not be much impaired; on the other hand, a very slight enlargement of the middle lobe may cause complete retention. A sound may be used, but as instruments are always an evil, it is better to take a catheter, and to direct the patient to empty the bladder first, so that not only the shape of the gland but the amount of the residual urine may be ascertained. The length of the enlargement may be judged by the distance the catheter passes before entering the bladder; the height to which the middle lobe rises by the depth to which the handle of the instrument must be depressed between the patient's legs. The most accurate information is obtained by carrying out the rectal and urethral examination together; the distance between the catheter and the finger can be estimated then, and the presence of irregular nodules or uneven enlargement of one lobe better made out.

Enlargement due to inflammation is distinguished by the pain and the sensation of heat in the rectum, but it must not be forgotten that a certain amount of chronic inflammation is not uncommon in enlargement of the prostate, even when instruments have not been used. How far the increase is due to passive congestion is much more difficult; but if the mucous membrane bleeds very readily when a large instrument is passed, and the hæmorrhoidal veins are much enlarged, it is probable that some at least is caused by this. In malignant disease of the prostate the growth is more rapid and the pain more intense, radiating from the perinæum down the thighs. Generally, too, it is softer, and profuse hæmaturia, towards the end of micturition, is the rule.

It is not sufficient, however, to make out that the prostate is enlarged, or even that the median lobe has grown out and obstructs the flow; the condition of the bladder must be ascertained as well, how far it is already in a state of atony, and what amount of residual urine is left. This can only be done by passing a catheter; but as this is a proceeding which is sometimes followed by very serious consequences, especially when done for the first time, or when there is residual urine, certain precautions should always be adopted. The patient should be directed to lie down and keep warm and quiet for the rest of the day; it is best for him to remain in bed, but at any rate he should not go out or expose himself to cold. Before the catheter is passed the bladder should be emptied as thoroughly as possible; the object is to find out the quantity that cannot be expelled; not unfrequently this must be done on more than one occasion before the amount can be definitely fixed, as from nervousness or other causes it often happens that the bladder does not act so well as usual. The best instrument is a soft rubber catheter of moderate size; or, if this will not find its way in, a black one with the point well bent up (*coudé*), or a gum-elastic fitted with a stylet, so that if its progress is stopped abruptly the end may be tilted up. If a large amount of residual urine has been drawn off (more than five or six ounces) a smaller quantity of a warm antiseptic solution should be introduced and left; the bladder cannot readily accustom itself to such altered conditions, and must be gradually educated, the quantity being reduced every second or third day. In all such cases the patient should be cautioned that there is almost certain to be some slight fever after the operation, and that rest in bed until the temperature is normal and the bladder has grown accustomed to its new condition is absolutely essential.

Treatment.—1. *Palliative.* (*a*) *General.*—The treatment of enlargement of the prostate depends upon the condition of the bladder. If the patient's rest is not seriously disturbed at night, and if there is only a small amount of residual urine, every effort must be made to maintain the strength of the muscular coat and prevent it being strained. The bowels must be opened regularly; micturition performed at stated times; a regular amount of fluid taken, anything late at night especially being avoided; and wines and spirits consumed very sparingly. The clothing should be warm, so that there is no sudden chill or congestion of internal organs; and, especially if there is any tendency to gout, the diet should be light and without much meat, so that the urine may be as little irritating as possible.

(*b*) *Catheters.*—If, however, as generally happens, the atony of the muscular coat is already advanced, and if two or three ounces of residual urine are found in the bladder on more than one occasion, showing that it is habitual, means must be taken to remove it thoroughly, at least once in the twenty-four hours. It is true that the passage of a catheter, under these conditions, is liable to cause urinary fever, even when every precaution is adopted; and that, if no other treatment than that already described is employed, the patient may go on for some years, though with great inconvenience; but, all that time, the amount of residual urine is increasing, the muscular coat of the bladder is becoming weaker, its recuperative power more feeble, and the kidneys more and more diseased; so that, when at length, after years of suffering and apprehension, the catheter becomes absolutely necessary, urinary fever of the worst sort is almost certain to follow. There is abundance of evidence to show that the ill results which are occasionally met with after catheterism in cases of enlarged prostate not complicated by cystitis, are proportionate in their severity to the amount of residual urine, and postponing the commencement of catheter-life until it cannot be avoided merely means running a far greater risk of urinary fever, without having, in the meantime, increased in any way the patient's comfort.

The instrument should be the softest and most flexible that can be introduced; and the greatest care must be taken that it is thoroughly cleansed inside as well as out, before as well as after using. It is not a bad plan to keep it in a solution of carbolic, frequently changed, though the catheter itself soon becomes spoiled. The best time for beginning is when the patient is warm in bed, and, if he is not already accustomed to the use of instruments, he should be recommended to keep in bed for a couple of days, and to remain in his room for a week, even if all goes well. A week is none too long to give up altogether in such a case. The bowels should be kept open ; a warm hip-bath taken every night ; and, if the kidneys are sound, and the urine of fair specific gravity, a small dose of opium may be given an hour or two before the catheter is passed. The temperature should be watched, and, if there is the least shivering, a full dose of quinine given in a cupful of hot tea. Unfortunately, the form of urethral fever that occurs in these cases is not that characterised by a single severe rigor, with temporary renal congestion, and which, though exceedingly alarming, is rarely followed by serious results. Much more frequently the fever is continued and commences insidiously, the temperature not rising for some hours, and then rarely reaching 102° or 103° F. When this occurs the most prominent feature is the prostration ; the pulse becomes quick and small ; the tongue brown and furred, and the eyes sunken ; there is constant delirium, especially at night ; the patient is incessantly trying to get out of bed ; the quantity of urine is deficient ; its specific gravity is below normal and it always contains mucus and generally albumin. Symptoms of this kind seldom occur unless the kidneys are already in a state of advanced interstitial nephritis—the secreting power is already diminished ; the additional irritation setting up congestion, leads to partial suppression ; typhoid symptoms follow, and, unless there is a rapid change, uræmia and coma are inevitable.

As soon as the bladder has become accustomed to the sensation of being emptied, and the urethra to the passage of a catheter, the patient may be taught to pass one for himself. The best time is the last thing at night, before retiring to rest, so that some hours' sound sleep may be secured ; but, if the amount of residual urine is constantly above three ounces, the instrument should be passed night and morning ; and, if between three and six, three times a day. It is better to do it too often than too seldom ; if distension is avoided, the muscular coat may regain some of its power, and though the residual urine never disappears altogether, it diminishes considerably in quantity. One single instance of over-distension, however, is sufficient to undo all the good. When once the commencement of catheter-life has been passed, there is no reason why, if only reasonable precautions are taken, especially against the occurrence of cystitis, the patient should not resume active habits of life again.

When there is cystitis, more active measures are required. It may be due to the catheter, or to an irritating condition of the urine, or possibly to the obstruction caused by the projecting masses of the prostate ; whatever the cause, if left to itself, it can only grow worse and spread to the ureters and kidneys. The bladder is unable to empty itself, the irritability of the mucous membrane is so intense that the contraction never ceases ; the muscular coat becomes hypertrophied ; the alkaline mucus collects in the post-prostatic pouch, from which it cannot be evacuated ; the urine becomes peculiarly offensive ; at length ammoniacal decomposition sets in, and the inflammation, which at first was simply catarrhal, runs on rapidly to ulceration and sloughing.

As soon as it begins the bladder must be thoroughly washed out, so that the post-prostatic pouch may be completely cleared. If there is a profuse secretion of mucus (catarrh), hot salt and water (a teaspoonful to the pint) may be used first, and then a mild astringent, acetate of lead (gr. j ad ℥j), nitrate of silver, or better, bichloride of mercury (gr. ½ ad ℥j), on account of its powerful antiseptic qualities. Permanganate of potash, borax with glycerine, quinine, tannin, and many other substances have also been used. If there is much phosphatic deposit, dilute nitric (♏j or ♏ij ad ℥j), or phosphoric (♏iij to ♏iv ad ℥j) acid is of service. Meantime the patient should be kept warm, if possible in bed, on light or even milk diet; baths should be given every night, the bowels kept well open, and the state of the urine carefully watched. Stimulants do no good, but sometimes they must be given. If the irritability is very great, morphia suppositories may be tried, or a few drops of tincture of opium injected into the bladder after it has been washed out. Quinine appears of service when given internally, possibly because some of it is excreted in the urine; and, if it does not upset the patient, benzoate of ammonia helps to keep the urine acid; but the cause and the treatment are both mainly local.

(*c*) *Drainage.*—Patients with enlargement of the prostate have been known to live for thirty years in comparative comfort, using a catheter two or three times a day; but not unfrequently, as age advances, the bladder becomes more irritable, and the necessity for passing an instrument more frequent, until at length it has to be done every hour, night and day, rendering existence a burden. The prostate is swollen and tender; sometimes there is ulceration at the neck of the bladder, causing extreme tenesmus; or there are pouches which cannot be drained and which are constantly infecting the rest of the urine; or the bladder has become so rigid and contracted that it can only retain a few ounces; and sometimes there are calculi. At length the suffering becomes extreme; day and night there is most agonising pain; the catheter is wanted every minute, and every time it is passed only makes the condition worse.

Temporary relief in these cases may always be obtained by draining the bladder. This is easily done by the operation known as ‘la boutonnière.’ The patient is anæsthetised, placed in the lithotomy position, and a grooved staff passed into the bladder. The left forefinger is placed in the rectum to fix the apex of the prostate, and an incision three-quarters of an inch in length made exactly in the middle line of the perinæum, an inch in front of the anus. This is deepened until the membranous portion of the urethra is opened behind the bulb. A director is then passed along the staff into the bladder, the staff withdrawn and the forefinger of the right hand gently pressed through the prostatic urethra, dilating it as it goes. If no calculus is found, and there is nothing about the shape of the prostate or in the cavity of the bladder to account for the persistence of the symptoms, a large rubber tube is passed through the perinæal wound into the bladder, and connected with a receptacle under the bed, so that every drop of urine flows out at once. The effect of this is most striking: the need for the catheter ceases entirely, the night's rest is uninterrupted, the pain disappears, and the patient can sit up comfortably in bed. The mucous membrane, being no longer in constant contact with foul decomposing urine, begins to throw off its coating of mucus and phosphates, the ulcers heal, the absorption of septic material from the bladder ceases, the reaction of the urine becomes acid again, the blood disappears, and the deposit begins to diminish. As soon as the condition of the bladder is thoroughly restored, the tube may be withdrawn and the opening allowed to close.

Harrison adopts a simpler process. A straight trocar and cannula is introduced in the middle line of the perinæum an inch in front of the anus and pushed through the substance of the prostate until the bladder is tapped; then the trocar is withdrawn, a self-retaining catheter introduced in its place, and the cannula removed. As soon as the urine begins to improve, the patient is allowed to get up and move about; and, if it is thought desirable, the apparatus may be permanently retained, the catheter being connected by means of a rubber tube with a urinal strapped on to the leg. The amount of leakage by the side is very slight. In most cases, after a few weeks the urine begins to come through the urethra again; and this may be taken as a signal that the drain is no longer needed. Harrison has noted the curious fact that in several of these cases the prostate has shrunk to such an extent after the operation that the enlargement can hardly be detected through the rectum, and the patient experiences little or no difficulty with his urine afterwards.

In extreme cases, in which, owing to the enormous size of the prostate or to other special complications, a permanent opening affords a better chance of relief, suprapubic puncture may be performed; or the bladder may be deliberately opened in the same region and cleared of all adhering mucus and phosphates, a properly arranged tube and urinal being worn afterwards, as in cases of impermeable stricture.

Other complications that occur in the course of enlargement of the prostate may require special treatment. Retention of urine must be relieved by catheter as soon as possible. The muscular coat is already in a state of partial atony, and a slight degree of over-distension is sufficient to increase it until the power of contraction is permanently lost. If a catheter cannot be passed, hot baths and similar remedies are useless; an opening must be made in the bladder at once, but the necessity for this is very rare.

Hæmorrhage is seldom serious; sometimes it appears to give relief, especially the slight amount which in some patients is so constant as almost to deserve to be called periodic. When it follows the use of a catheter it may either be due to rupture of the engorged veins, or to the effect of suddenly relieving the pressure upon the wall of the bladder. In either case the blood and the urine are intimately mixed, and though the colour may be bright red just at first, it soon becomes smoky and brown. The patient should be kept quiet in bed, and the urine drawn off as occasion requires with a soft catheter; special treatment is seldom needed. If it persists, the bladder may be washed out with an iced infusion of matico or tincture of hamamelis, and opium with gallic and sulphuric acids given internally. Clots, as a rule, disintegrate of themselves, but they may require an evacuator.

If there is extreme pain at the neck of the bladder when the catheter touches a certain spot, and ulceration or fissure can be diagnosed by the endoscope, a solution of nitrate of silver (gr. v ad ℥j) may be brushed over it with a properly arranged injector. Sacculi in the walls should be drained and washed out like the rest of the bladder, but the openings are so small that it is seldom possible to find them without the aid of a cystoscope. The ordinary method of washing out the bladder merely tends to make them larger, as it fills them under pressure with fluid which they cannot expel again. On the other hand, there are several cases on record in which regular drainage has led, if not to their disappearance, at least to their causing no further trouble. They may sometimes be suspected from the peculiar character of the urine, or from the way in which a catheter, after passing the normal distance and drawing off one kind of urine, suddenly slips in farther and draws off something different.

Phosphatic calculi are not at all uncommon, but fortunately they are so soft that they can be crushed and washed out without prolonged instrumentation. It is always advisable, however, not to allow them to attain too large a size. Recurrrence is very common, as the same conditions persist.

2. *Operative treatment.*—In performing lateral lithotomy portions of the prostate have often been removed without ill consequence of any kind. Some of these were pedunculated masses projecting into the urethra or the bladder, so that they were caught (occasionally by accident) in the blades of the forceps; others were growths in the substance of the gland itself, which shelled out from the pressure of the finger as soon as the tissues around them were incised. Moreover, the gland has been repeatedly punctured from the perinæum, and, by means of catheters, through the urethra. Occasionally there has been hæmorrhage, and suppuration and sloughing have been known to follow, though rarely; as a rule the wound heals without difficulty, sometimes relieving the condition of the bladder by making a direct channel to the pouch behind. In a few instances it has been noticed that after these partial operations the prostate has undergone a kind of subinvolution, and diminished to an extent that cannot be accounted for even when allowance is made for the cessation of the congestion and for cicatrisation. Whether in this there is a further analogy to the fibromyomata of the uterus remains to be proved. Unfortunately it does not happen with sufficient frequency to enable any reliance to be placed upon it.

In some of the cases in which the residual urine has been drained in this way, even when the amount was large, the bladder has recovered its tone, the irritability has subsided, and catheters have been dispensed with. The question therefore arises whether it is not possible, without running too much risk, to produce the same result at an earlier period, before the bladder and the kidneys are irretrievably ruined.

There are three ways in which the prostate may be approached: through the urethra, through the perinæum, and, after suprapubic cystotomy, through the bladder.

(*a*) *Urethral operations.*— Of these the best known are Mercier's and Bottini's. In the former an instrument shaped like a short-beaked lithotrite, with tolerably sharp edges, is used to punch out portions of the floor. In the latter a fresh urethra is bored through the substance of the gland by means of the galvano-cautery.

This has been done on several occasions (once on a medical man without an anæsthetic) with very distinct benefit. In the first case the residual urine amounted to thirteen ounces, and the dysuria was so great that a catheter had to be passed every two hours night and day; the operation only lasted forty-five seconds; there was no fever afterwards, and the bladder regained a great deal of its power. In others, however, there has been severe vesical tenesmus after the operation, and sloughs have continued to come away through the urethra for upwards of three weeks.

(*b*) *Perinæal operation.*—In this an incision is made in the middle line, in front of the anus, and the membranous portion of the urethra opened as in the operation for draining the bladder. The finger is then passed into the prostatic portion and the obstruction dealt with according to its shape and position. A median outgrowth, if sufficiently pedunculated, may be excised or removed by means of a snare; if it is sessile it may be punched out with a modification of Mercier's prostatome, or incised with a straight probe-pointed knife, and then torn with the finger until the passage into the pouch is straight. Sometimes it answers better to pass a curved bistoury through the substance of the gland into the post-prostatic pouch, and cut into the urethra so as to ensure that the division is complete. Afterwards a full-sized drainage-tube is introduced and retained until the urine begins to come by the natural route. When it is withdrawn the perinæal wound usually closes rapidly. If the section is sufficiently deep a catheter is not required afterwards, but it should still be passed occasionally as a precaution.

(*c*) *Suprapubic operation.*—This was first performed after the removal of calculi, and subsequently as an independent operation. The rectum must be distended, as in suprapubic cystotomy, and the incisions through the abdominal wall and into the bladder made with the usual precautions. The finger is then introduced to ascertain the size and shape of the mass. There are, according to McGill, three chief varieties admitting of surgical relief: in the first there is a uniform circular projection surrounding the internal orifice of the urethra; in the second a sessile enlargement of the median lobe situated partly in the prostatic urethra and partly in the position of the uvula vesicæ; in the third a pedunculated outgrowth. Of these the last can be removed easily with scissors, and the second may be treated in the same way by dividing the mucous membrane over it freely and tearing it with forceps. The scissors should have long handles with short blades, curved in various directions. The collar enlargement is more difficult. McGill divides it longitudinally, first in front and then behind, by inserting one blade of the scissors into the urethra, and cutting in each direction. By this the projecting part is divided into two halves, which can be removed by enucleation with the finger. The whole of the projecting valve must be excised, and after the operation the forefinger must be passed down the urethra, to make certain that it is free. Hæmorrhage is checked by a hot antiseptic solution; and the bladder drained with a tube through the lower angle of the wound for forty-eight hours.

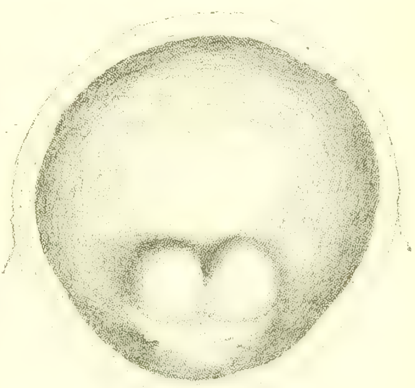
FIG. 441.—Neck of the bladder seen from within, in a case of enlarged prostate. The orifice of the urethra lies in the angle between the two projections.

It is impossible at the present time to give a definite opinion as to the relative or absolute merits of these operations. The last is the most complete, but at the same time by far the most serious. Mercier's is certainly insufficient, and shares with Bottini's the grave disadvantage of uncertainty. It is scarcely possible, even with the aid of the sound and the cystoscope (when this can be used), to obtain sufficiently definite information concerning the relations of the prostate and the bladder under their altered conditions.

The choice between the suprapubic and perinæal operations rests on different grounds. There are three chief factors upon which the selection depends; of these two can be ascertained before anything is done; the third cannot. One is the distance of the bladder from the perinæum; if this is more than three inches and a half the finger cannot reach it, and the operation becomes exceedingly difficult. Possibly the urethroscope with a very wide tube, used through the perinæal opening, might prove of assistance, but the view would soon be obscured by the bleeding. The second is the condition of the bladder; if if is small, rigid, and degenerate from chronic cystitis, the suprapubic operation is out of the question. The third is the shape of the obtruding mass. In a small proportion of cases this is such as to preclude effectual removal through a perinæal opening, but this can only be ascertained by actual exploration.

The perinæal operation is the more simple: it gives much better drainage, and these cases nearly always require it, owing to the presence of cystitis, and perhaps ammoniacal urine. I have performed prostatotomy through it on several occasions with very great benefit; prostatectomy, sufficient to remove the median obstruction and relieve the bladder, is possible in a large proportion of cases; and, finally, in the few instances in which prostatectomy cannot be managed in this way, and is possible by the suprapubic method, the perinæal opening does not add materially to the gravity of the operation, and is of the greatest assistance for draining the bladder and preventing septic absorption afterwards.

Malignant Disease of the Prostate

Carcinoma and sarcoma both occur, but the former is the more common. It is usually of the glandular or spheroidal-celled type, and is more often soft than hard. Colloid carcinoma has also been described.

Symptoms.—Carcinoma is generally met with after middle life; sarcoma may occur earlier. The symptoms at the first are the same as those of simple enlargement or chronic inflammation, but they soon become more intense and acute. The obstruction to the flow of urine comes on more quickly; the uneasiness and frequency of micturition are more marked, and the pain is more severe, radiating from the perinæum down the thigh and to the end of the penis. Later, as the disease advances, it may become agonising. Hæmorrhages are common, often profuse, occurring with or without micturition, and tending greatly to reduce the patient's strength. Cystitis and decomposition of the urine follow; the glands in the iliac region become involved, and death usually occurs in a comparatively short time from exhaustion, interference with the urinary secretion, want of rest, and pain.

Operative treatment is practically out of the question, though in one or two instances obstructing portions have been removed with a certain amount of benefit. Suprapubic puncture at an early period is more effectual, though this cannot relieve the pain. The bowels must be kept gently relaxed, a soft catheter used when required, the interior of the bladder washed out with weak antiseptics, and the pain controlled, as far as possible, by means of morphia.

PROSTATITIS

Inflammation of the prostate may be either follicular or parenchymatous. In the former, the mucous membrane and the follicles opening upon it are chiefly concerned; abscesses may form, but they are rarely large, and they always burst into the urethra. In the latter, the whole substance of the gland is involved; and, if suppuration occurs, the pus may spread into the tissues around, and point in the perinæum, or even in the groin.

1. *Follicular Prostatitis*

This may be either acute or chronic. The former is usually due to gonorrhœa, but it may be caused by injury (impaction of calculi, the passage of large instruments, or the use of caustics), especially if the gland is already in a state of congestion from excessive sexual excitement, advanced stricture, or other causes. Bicycle riding is said to produce the same effect. It is very doubtful if simple irritation by the urine is sufficient to bring it on, though it may prevent its getting well. The chronic form is either the result of the acute, or commences as such, from similar causes acting with less energy.

(*a*) *Acute.*—This usually occurs during the acute stage of gonorrhœa; but it may be brought on later by the use of injections or the passage of instruments. There is intense burning at the neck of the bladder; the desire to pass water never ceases; the stream from the first is small; a few drops only are ejected, without the least relief, and even this may be impossible. There is violent throbbing in the perinæum; the pain extends down the thighs and into the loins; in the rectum there is a constant sense of fulness and tenesmus, with great suffering as soon as the bowels begin to act; and, if the finger is introduced, the prostate feels swollen and burning hot. The temperature rises from the first; the pulse becomes full and quick; the distress is very great, and not unfrequently there is high fever. Suppuration is usually, but not always, indicated by a chill.

When the inflammation is due to other causes the course is generally less severe; and occasionally large chronic abscesses form in the substance of the gland, without any marked symptoms other than those of irritation about the neck of the bladder and obstruction to the passage of urine.

If the treatment is active and early, the symptoms usually subside. Occasionally the inflammation becomes chronic; the irritability and pain persist, though with less severity; there is a certain amount of discharge washed down by the first few drops of urine; and whenever there is the east indiscretion, all the old trouble threatens to return.

Treatment.—The patient should be confined to bed and placed upon milk diet; a hip-bath, as hot as can be borne, should be given twice a day, nd the bowels should be freely opened once; after that it is better to leave hem alone, owing to the pain and need for local rest. The rectum may be ashed out with hot enemata, leeches applied to the perinæum, and the eeding encouraged by fomentations. The pain must be relieved by sup-ositories or hypodermic injections of morphia. Sometimes the inflammation n be cut short by full doses of vinum antimoniale every hour, until nausea produced. If retention occurs, the urine must be drawn off with a catheter, either a soft rubber one of medium size or a black one, *coudé*, so that it can ride easily over the obstruction.

If suppuration is suspected, and there is any redness or fulness in the perinæum, a free median incision should be made; if pus is not found, the hæmorrhage will give relief; but, though this is not uncommon when the suppuration is in connection with the membranous portion of the urethra or Cowper's glands, it rarely occurs in prostatitis. Generally the abscess bursts into the urethra, either of itself or when a catheter is passed: there is a profuse discharge, and at once a sensation of intense relief. Owing to the extreme tension, the cavity contracts immediately, and, so long as the abscess is acute, fistula and extravasation of urine rarely follow.

(*b*) *Chronic follicular prostatitis.*—This may be the relic of an acute attack, or it may result directly from gonorrhœa, stricture, or prolonged masturbation.

The symptoms are the same, but of less severity; and the affection is often mistaken for calculus. There is increased frequency of micturition; the stream flows away, especially the last few drops, without any force; almost always there is pain and scalding towards the end, and sometimes a few drops of blood escape at the same time. Shreds of mucus and casts of the prostatic follicles accumulate in the urethra, and are either washed down with the first few drops, or exude from the meatus during defæcation. In the latter case, they are often mistaken for the secretion of the testes, and the patients are convinced that they are suffering from spermatorrhœa. Gleet is not present unless the penile portion of the urethra is involved as well.

Examined through the rectum, the gland feels enlarged and tender. There is constant aching in the perinæum, extending down the thighs and across the loins, much more severe during defæcation and micturition, because then the prostate is compressed. The constant straining usually brings on hæmorrhoids as well; the irritation spreads to the bladder, and cystitis follows; at first it may be slight, but by degrees the walls become hypertrophied and lose their flexibility; and, then, often it is not properly emptied, even though the patient may pass water every hour. At last the health breaks down altogether, and mental as well as bodily vigour is seriously impaired.

Treatment.—This affection is generally of a most obstinate character, and requires prolonged and careful attention. Fresh air and change of scene are often necessary; the food must be good, but not rich; stimulants, especially beer, sherry, and champagne, must be prohibited; and tonics, iron, nux vomica, cod-liver oil, and phosphoric acid, given according to the condition of the patient. The bowels should be kept slightly relaxed, so that there may be no straining at stool; and excessive exercise, especially on horseback, or on a bicycle, and sexual indulgence must be honourably avoided.

In most cases local treatment is essential. Lightly blistering the perinæum is sometimes of service; small patches should be painted over with blistering fluid on successive days, taking care to avoid the skin of the scrotum, and, if possible, not raising actual vesicles; or a little dry mustard may be rubbed in. Astringent injections applied to the part itself are of grea advantage, using either an injector or a prostatic syringe. Glycerine and tannic acid; or five minims of a 2 per cent. solution of nitrate of silver or nitrate of bismuth may be applied without fear; stronger application (even twenty grains of nitrate of silver to the ounce) are employed by some but the pain they cause is very severe (though this may be prevented by cocaine), and their use is often followed by vesical tenesmus and a blood-stained discharge. The urethra should be washed out with hot salt and water first, to clear away adherent mucus, and the patient kept in the recumbent position for the rest of the day, as a precaution against epididymitis. If these fail, tannic acid, eucalyptus oil, and other astringents, made into bougies, may succeed; but they must be introduced with a proper instrument, as they are too soft to pass of themselves. They soon become liquid. and the mucous membrane remains for some time bathed with the products of their solution.

2. *Parenchymatous Prostatitis*

Gout, tubercle, and injury are the chief causes. Occasionally it is due to syphilis, and it is said that sometimes inflammation arises from exposure.

Gouty prostatitis is not uncommon towards middle life in men who live rather freely, and whose urine is loaded with uric acid. The commencement is tolerably acute, and is often assigned to cold: the fever is not so high as in the acute follicular form; there is very rarely retention of urine; and probably never actual suppuration. The irritability of the bladder is even more intense; the urine is ejected spasmodically, almost without the patient having any control, and the pain is very severe, especially at night. *Per rectum*, the prostate is distinctly enlarged, hardened, and exceedingly tender. Sometimes there is œdema of the prepuce, or partial erection from obstruction of the veins of the penis. Generally the attack subsides readily under colchicum and the alkaline carbonates; the bowels should be freely opened with blue pill; the diet carefully restricted, and a regular amount of fluid (hot water is the best) taken at stated times, to diminish the acidity of the urine and prevent any concentration. Gouty prostatitis may in some cases lead to the accumulation of residual urine: the gland is very sensitive, and, to avoid squeezing it, the patient never thoroughly empties the bladder; after a time, a certain amount is constantly retained; the walls become atonied, and the power of complete evacuation is lost.

Tubercular prostatitis usually occurs in young adults, in association with tubercular disease of the bladder or kidneys; sometimes it appears to follow an attack of gonorrhœa, but it is rare as a primary affection. In the earlier stages the symptoms are almost the same as those of calculus; micturition is much too frequent, the patient wanting to pass water every hour; hæmaturia is often present, especially as the neck of the bladder is beginning to contract; and, at the same time, there is a sharp cutting pain at the end of the penis. *Per rectum*, the prostate is seldom much enlarged; at first, it is rather harder than natural, and perhaps nodular; but, as the caseous masses break down and disappear, it may become abnormally soft. In the later stages, the urine brings away with it pus and caseating débris, full of tubercle-bacilli; the gland itself is completely excavated; the irritability and pain become unbearable; and the patient grows weaker and weaker. Generally speaking, there are deposits in other organs as well.

The **diagnosis** in the early stages, when there is some hope of removing or at least arresting the disease, can only be made with the endoscope. If this is not used, neighbouring organs, such as the bladder or vesiculæ seminales, are nearly sure to be involved before there is any definite evidence. Constitutional treatment is of great importance, but it does not seem to have the same influence over tuberculosis of the genito-urinary tract as when it occurs in other parts—the bones, for example. Locally, iodoform, applied in an emulsion or as a pessary, is of some service; but possibly, if the diagnosis were confirmed by microscopic examination, and it was fairly certain that the other organs were sound, it would be better, if speedy improvement did not take place with ordinary measures, to open the prostatic urethra from the perinæum, and try free scraping and the application of lactic acid. In the later stages morphia is the only drug that relieves the pain. If the disease is limited to the prostate the bladder may be drained through the perinæum; but, unfortunately, this often fails to give relief, owing to the other organs being involved as well.

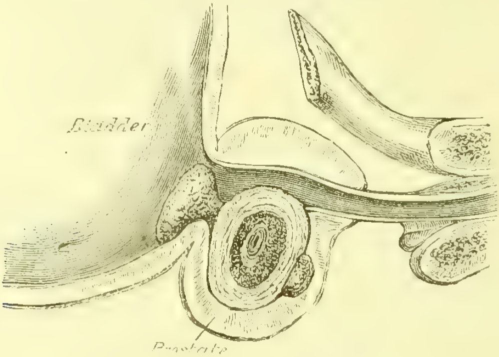

Fig. 442.—Prostato-vesical calculus.

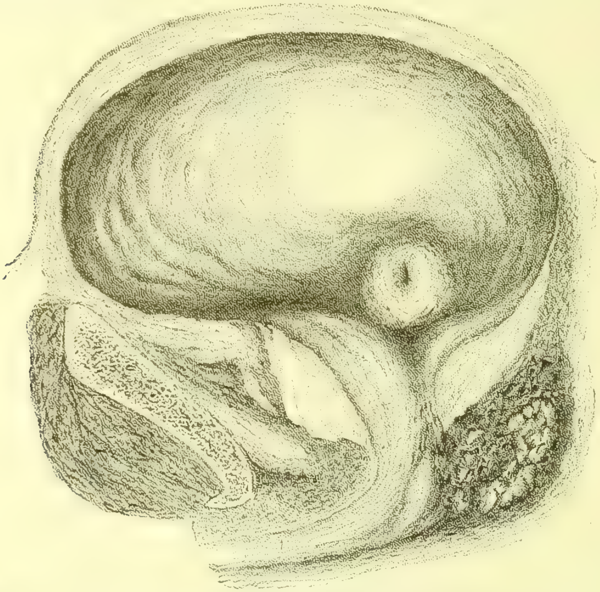

Fig. 443.—Prostatic calculi with some enlargement, causing prolapse of the ureter. (Section a little to the left of the middle line.)

Suppurative prostatitis.—Suppuration in and around the prostate is occasionally the immediate cause of death after lithotrity, operations about the neck of the bladder, or the passage of very large instruments, especially when there is old-standing disease of the kidneys. It may commence in the prostate itself, the gland being destroyed, the capsule giving way and the pus spreading in the loose tissue around the neck of the bladder, until, if the patient live sufficiently long, it points in the iliac fossa ; or it may be periprostatic from the first, originating in tissues that have been saturated with septic material by absorption from the bladder. There may or may not be a rigor ; as a rule the symptoms are exceedingly vague, being masked entirely by the vesical and renal trouble, and in the majority of instances the diagnosis is not made until the patient is sinking from septicæmia and suppression of urine.

Prostatic Calculi

Calculi occasionally leave the bladder and become impacted in the prostatic portion of the urethra ; under these circumstances they may sink into the substance of the gland, and become, as it were, encysted, with a portion of their surface projecting. True prostatic calculi, however, are not uncommon, originating in the follicles, and gradually growing larger and larger until the intervening tissue is absorbed, and they come into contact with each other. They are always multiple, rarely very large, and usually facetted from pressure ; as a rule they contain about 85 per cent. of phosphate of lime with a trace of carbonate, and about 15 per cent. of animal matter, but the proportion of the latter is sometimes higher towards the centre. In one or two cases they have coalesced into large masses. So long as they are small they do not give rise to any symptoms ; as they grow larger they may cause inflammation and even suppuration. In one case under my care, admitted for extravasation of urine consequent on this, there was, in addition to the prostatic calculi, a much larger one in the bladder, composed of bone earth with a little carbonate of lime.

CHAPTER XXIII

INJURIES AND DISEASES OF THE URETHRA

INJURIES OF THE URETHRA

THE mucous lining of the urethra may be torn by calculi, or perforated with catheters, or bruised from blows upon the perinæum, or from attempts at forcibly straightening out chordee; but serious consequences rarely follow. There is a small amount of hæmorrhage, perhaps sufficient to drip from the orifice; micturition is attended with scalding, and there is soreness about the part with a slight mucous discharge, but extravasation of urine seldom follows a superficial injury unless there is an obstruction as well.

False passages escape from their direction. They start in most cases from the floor, in front of the bulb, very often on the left side, and run from there between the bladder and the rectum, but the opening lies towards the meatus, so that urine does not enter.

Rupture of the urethra may be caused by a kick or violent blow in the perinæum, or by fracture of the pelvis.

In the former case the urethra is torn at the junction of the membranous and bulbous parts, the anterior layer of the triangular ligament giving way as well; sometimes the whole circumference is ruptured, and the ends are widely separated; sometimes there is only a rent on the floor, the roof remaining intact. Hæmorrhage is usually profuse, forming a swelling in the perinæum and scrotum, and often dripping freely from the meatus, but no urine is extravasated until an attempt is made to relieve the bladder.

In the latter, when the rupture is the result of fracture of the pelvis or separation of the symphysis, the deeper part of the urethra and the neck of the bladder generally suffer; blood does not escape externally until an attempt is made to pass urine; but this, from the moment of the accident, begins to leak out from the bladder and infiltrate the tissues around, setting up the most intense inflammation.

The symptoms depend upon the seat of injury. If the rupture is in front of the triangular ligament, or involves the anterior layer of it, a swelling rapidly forms in the perinæum; blood drips slowly from the meatus, and either the patient is unable to pass any urine, or, if he makes the attempt, it pours into the loose cellular tissue of the perinæum, causing the most intense burning. If an attempt is made to pass a catheter, either it stops abruptly at the seat of injury, the point rubbing against the lacerated tissues, or it suddenly slips onwards, entering the bladder and drawing off clear urine. This accident is nearly always followed by a stricture, the severity of which depends upon the amount of suppuration. If the rupture is complete, and there is the least infiltration of urine, the cicatricial tissue becomes so hard and dense that practically the urethra is closed (unless steps are taken to prevent it); if the mucous membrane is partly intact and there is no suppuration, there may be some obstruction, but the tendency to contraction is not nearly so severe.

On the other hand, when the deeper part of the urethra is torn, external hæmorrhage and swelling are rarely present, but the pain and the shock are much more severe, and, owing to the urine soaking at once into the cellular tissue, inflammation and fever soon set in. If a catheter is passed there is no difficulty until it begins to wind under the pubic symphysis; then it either stops altogether, or, if it can be introduced into the bladder, the urine that it draws off is loaded with blood. This injury usually proves fatal from infiltration of urine into the cellular tissue of the pelvis, in the same way as extra-peritoneal rupture of the bladder.

Treatment.—In every case of severe injury to the pelvis or perinæum a catheter should be passed as a matter of routine, to ascertain if there is any injury to the bladder or urethra. If it slips in at once, without any grating, or perhaps with a sensation of roughness of the mucous surface just at one spot, it may be withdrawn again; there is merely an abrasion or contusion of the mucous membrane, and, if the bladder is emptied and urine is not passed for some hours, the surface will glaze over. If, on the other hand, the catheter is brought to a sudden stop, or if the proximal orifice of the torn urethra is only found with difficulty, and perhaps after more than one instrument has been tried, steps must be taken to prevent infiltration.

(*a*) *Rupture of the anterior part of the urethra.*—If there is the least difficulty in passing an instrument into the bladder, or if it is clear from other evidence that the urethra is badly torn, the patient should be placed in the lithotomy position, a catheter passed down to the rupture, or through it, and a median incision made of sufficient length and depth to allow the extravasated blood to escape and prevent infiltration of urine. Tying a catheter in will not do this; urine always trickles by the side of it, no matter how large it is, and if the wall of the urethra is torn at any point, infiltration and urinary abscess are sure to follow. The blood collecting in the wound and in the cellular tissue around seems to encourage it, by the readiness with which it undergoes decomposition and the way in which it opens up the tissues for the urine.

Various methods have been tried to provide additional security against this. I have on several occasions sutured the two ends together; there is no difficulty, especially in young subjects, in whom the perinæum is yielding. The finger placed in the rectum, forcing the tissues out through the wound, brings the proximal end of the torn urethra quite to the surface, so that sutures can be readily passed; but I have never succeeded in obtaining union by the first intention, and it has seemed to me that not only is the additional bruising which this entails injurious, but that there is a great tendency for the two parts of the urethra to unite at an angle with a spur between. Tying a catheter in after the incision has been made might prevent this, but in many cases it is a very serious irritant, causing grave reflex disturbance, and of itself tends to prevent union, so that it would do more harm than good. There is no difficulty, four or five days after the injury, in finding the proximal end and guiding into it a catheter passed down the penis.

Draining the bladder directly through the perinæum or the rectum, so that no drop can flow down the urethra until the wound is healed, has been recommended; but in the slighter cases it is not required, and in the more severe ones the extravasation of blood is so great that an abscess is almost sure to follow at the seat of injury.

In any case, a soft catheter must be passed every second day at least, commencing not later than the end of the week; for although there are cases on record which prove that rupture of the urethra treated by early incision does not of necessity lead to traumatic stricture, there is no doubt that it is liable to.

(*b*) *Rupture of the deeper part of the urethra* does not admit of this, or of suture. All that can be done is to drain the bladder as efficiently as possible through the perinæum, in the hope that if urine has already been extravasated, the suppuration that follows may be kept within bounds. Unhappily, in nearly all these cases there is a fracture of the pelvis, which, in this way, becomes compound into an ill-drained suppurating cavity.

Calculus in the Urethra

Calculi are occasionally formed in the urethra in the dilated and fasciculated pouch that develops behind a stricture; but nearly always the nucleus is carried down from the bladder. The symptoms depend upon the degree of obstruction; if the calculus is large enough to block the urethra of itself, or so sharp and angular as to bring about the same result by the spasm that it excites, retention occurs; and if speedy relief is not given, ulceration and extravasation follow. If, on the other hand, it is small and lodged in a diverticulum, it may continue to increase from the deposit of phosphates on its surface and wear its way into the tissues, until at length it forms an enormous mass, lying in the substance of the penis, alongside the urethra, almost buried under the mucous membrane.

Impacted calculus.—This is more common in children than in adults, owing to the greater frequency of stone in them and the small size of their urinary passages; the calculus is washed down from the bladder during the act of micturition and suddenly arrested, generally in the membranous part or at the meatus. The stream stops suddenly, there is a sharp cutting pain at the end of the penis with violent straining, and perhaps a few drops of blood exude from the urethra, especially if the calculus is sharp and angular. For a time the straining continues, the bladder becomes more and more distended, and then either sudden extravasation occurs, or, if a small quantity of urine can escape by the side, so that there is not such immediate tension, inflammation sets in, ending in urinary abscess and fistula.

There is seldom any difficulty in the diagnosis. The history of the case, the way in which the child keeps screaming and pulling at the end of its penis, the retention of urine which is so rare in children from any other cause, and the few drops of blood, are distinctive. Very often the calculus can be felt from the outside. If this cannot be done, a small catheter may be passed down the urethra; sometimes it comes to an abrupt stop against the stone, sometimes it slips by the side of it with a rough grating sensation, and entering the bladder, gives relief for the moment. If any time has elapsed since the accident, the bladder may be distended up to the pubes; or there may already be a swelling in the perinæum due to inflammation and commencing extravasation.

A calculus in the penile part can generally be worked forwards with the fingers until it reaches the orifice, when a small incision may be necessary to extract it. If this does not answer, a scoop or a pair of urethral forceps may be passed down the urethra, and an attempt made to draw it forwards; but this is very likely to inflict serious injury upon the mucous membrane. If it is fixed or too far back for this, the patient should be placed in the lithotomy position, the skin over the projection stretched with the finger and thumb of the left hand, and a small median incision made down on to it. Generally the calculus springs out at once, and the wound can be left to granulate. The bulb should, if possible, not be incised. If the calculus is near the neck of the bladder it should either be removed by the median operation, or, if there is a suitable instrument handy, pushed farther back and crushed with a lithotrite.

Foreign bodies introduced into the urethra may require extraction. Urethral forceps should be avoided as far as possible; sometimes, by placing the patient in a hot bath, giving him plenty of liquid to drink, and directing him to hold his water, sufficient head can be obtained to drive out such an obstruction, for example, as the end of a catheter broken off in a stricture; but this should not be tried too long. Hair-pins, on the other hand, and such like structures, nearly always require incision.

The cases in which the obstruction is slight and the stone lies out of the way are much more rare, and as a rule are only met with in elderly men. In a few instances huge cylindrical calculi have been found, three or four inches in length and one and a half in circumference. These generally lie in the tissues by the side of the urethra, occupying a cavity which they have worn out for themselves, and sometimes are so invested by the mucous membrane that a sound passed down the urethra slips by them without any of the characteristic grating.

The passage of Catheters, and the general effect of Operations upon the Urethra

Catheters are made of various materials, some rigid, others flexible in various degrees. Metal ones have a fixed curve, occupying a quarter of a circle of a radius of three and a half inches. (Prostatic ones should be fifteen inches long, and the radius of the curve barely three.) The handle should be bent a little downwards, so that if the patient is lying down the urine may not be ejected all over the bed; the other end should be solid, with a smooth eye on the side about a quarter of an inch back. If it is hollow to the end the space beyond the eye is never cleaned.

Gum-elastic catheters are made of webbing coated with copal varnish. Like the former, they follow the roof, but their flexibility depends upon temperature, and they can be bent to any shape. In cases of enlarged prostate, for example, if the point of the catheter is arrested by the median lobe, it can be tilted over it by withdrawing the stylet.

Black catheters are much more flexible, and follow the floor. The shape differs according to the requirements of the case; some have a minute bulb at the end, mounted on a slender neck so that it can follow the most devious route; others are rigid and bent upwards at an angle (*coudé*), so as to ride over an obstruction; others, again, are bent up twice in the same way (*bi-coudé*).

Vulcanised india-rubber catheters are mere rubber tubes, closed at the end and provided with a lateral opening; they are especially useful for patients who have to pass instruments for themselves, or where, as in cases of fracture of the spine, the urethra is absolutely insensitive. Celluloid instruments are too brittle to be of general use, but they are particularly suited for tying in the bladder, as they are much less affected by urine than the others.

The sizes of English instruments are arbitrary ; the smallest ($\frac{1}{4}$) is about one-fifth of an inch in circumference ; the largest (12), nearly seven-eighths. French ones are accurately graduated from one millimetre circumference up to forty.

Flexible instruments should always be preferred to metal ones. If there is a very tight stricture and it is impossible to introduce a soft one, a small metal one may be tried, but, owing to the fineness of their points, they are exceedingly dangerous. An exception to this rule may be made in the case of an enlarged prostate of many years' standing, in which, after perhaps years of self-catheterisation, retention has occurred at last. A full-sized silver prostatic one, with a very long curve, will as a rule ride over the obstruction, and squeeze its way between the swollen and congested walls of the urethra more easily than any other. Great care must be taken with the smaller black ones, as the varnish soon becomes cracked at the eye, and then the bulb is very likely to break off and be left behind.

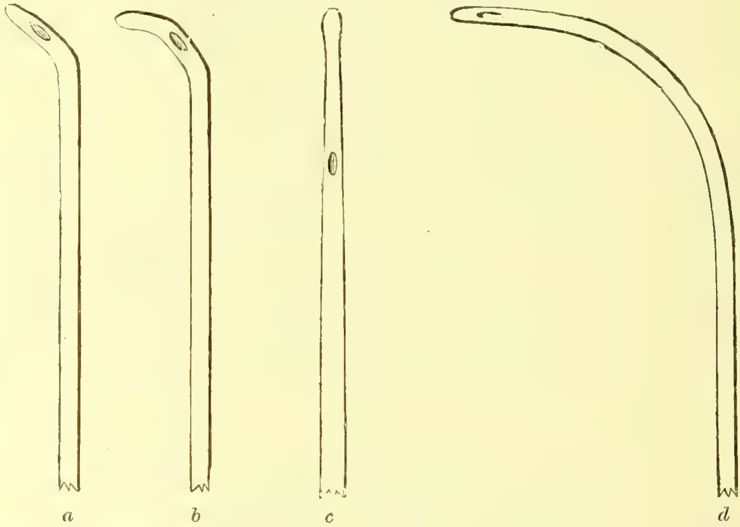

FIG. 444.—Various forms of catheters: *a*, coudé ; *b*, bi-coudé ; *c*, olivary ; *d*, prostatic.

Unless the state of the urethra is known, a moderate-sized instrument, No. 8 or 9 English (15mm. to 17mm. French) should be used to commence with. A larger one gives more pain, a smaller one may catch in a fold of the mucous membrane.

The patient should be in the recumbent position, with the umbilicus exposed and the thighs slightly flexed and abducted. The instrument is warmed and lubricated, preferably with Lund's oil (almond oil ℥j, castor oil ℥j, and pure carbolic acid ʒj) ; or, if there is a stricture, a drachm of oil may be injected first. The operator stands on the left, and, holding the penis with his left hand, draws it well over the point of the instrument, putting the mucous membrane on the stretch, so as to obliterate its folds. The point of the instrument should follow the floor of the urethra for the first inch, to avoid a diverticulum occasionally left during development, after that the roof for the rest of its course.

In a normal urethra, either the catheter experiences no resistance at all, but merely sinks down of its own weight, or, after passing two or three inches, is quietly and slowly gripped, and held by the unstriped muscular fibre in the wall. There is no sudden stop (so that there is no resemblance to the resistance of a stricture), and in a minute or two the instrument becomes free again ; the fibres have tired themselves out.

As the bulb is reached, owing to the dilatation on the floor and the softness of the mucous membrane, the point of the catheter may catch against the lower edge of the opening in the triangular ligament. Very little force, then, at the end of a long lever, will drive it through the mucous membrane and make a false passage. The instrument must be withdrawn a little, and the handle gently lowered. If there is the least difficulty, the forefinger placed in the rectum will find the cause at once ; but the utmost gentleness is required, or the point may slip over the edge in the right direction, but with a painful jerk. Withdrawing the stylet in a gum-elastic catheter has the same effect. Well-made black ones, with a sufficiently flexible neck, rarely cause this trouble.

The last obstacle is the neck of the bladder ; very often the point catches on the floor again, even when the median lobe of the prostate is not enlarged, and the obstruction must be surmounted in the same way.

The best time for passing a catheter is in the morning, an hour or two before the patient gets up, so that he may remain warm. If this is not practicable, care at least should be taken that there is no exposure to cold afterwards, and that micturition is not performed until it is absolutely necessary. With many patients, especially those who have suffered from ague, or who have lived in the tropics, it is advisable to give quinine for several days previously ; and, if the kidneys are sound, one small dose of opium ; but care should be taken that the bowels are not confined. A sixth of a grain of morphia, hypodermically, a few minutes before the operation, diminishes the irritability of the urethra, especially if the injection is made in the region of the perinæum. In all cases, except of course where there is urgency, a previous examination of the urine, both as to quantity and quality, should be made.

The passage of a catheter, especially for the first time, is a very painful proceeding, and may be followed by serious consequences. The *pain* is always worst as the instrument is passing through the membranous part ; it is usually described as cutting or burning, and it may cause syncope. If it is very severe before this point is reached, there is probably some morbid condition of the mucous membrane. Fortunately, it can be prevented by injecting a few drops of a ten per cent. solution of cocaine down the urethra.

Other consequences arise from the effect upon the nerve-centres. Thus shock may affect the wall of the bladder, causing *retention* (especially if atony is already present) ; it may paralyse the vasomotor nerves of the kidneys, leading, according to its severity, to *hæmaturia*, or *suppression of urine* (particularly in cases in which the kidneys are already diseased) ; or it may involve the central nervous system ; for *syncope* (probably from dilatation of the abdominal vessels) and sudden *death* have been known to follow.

Others, again, of which *urethral fever* is the most important, are of more doubtful origin. There are two chief forms of this: in the one there is intense shivering with headache, depression, and vomiting; the temperature rises rapidly to 104° or 105°, and then begins to fall almost as quickly as it rose, while the patient lies in a state of utter prostration, sweating profusely: in the other the temperature falls at first, then rises slowly until it reaches 102° or 103° F., sometimes with a rigor, but rarely a severe one, and after a few hours, if the kidneys are sound, gradually sinks again.

This may occur after the operation, or more frequently after the first subsequent act of micturition, especially if it takes place soon. Those who have suffered from ague, or have lived in malarial districts, are particularly liable to it; exposure to cold is especially likely to bring it on, and there is no doubt that, though it does occur in those whose kidneys are perfectly healthy, it is more likely to happen and much more likely to be followed by serious consequences when they are diseased. In fatal cases intense renal congestion is usually found, but it is not improbable that this is a coincidence due to the effect upon the vasomotor nerves, and that rigors may occur independently of it.

Opinions differ with regard to its etiology: Harrison considers it due to the absorption from the urine of toxic alkaloids, which undoubtedly are produced in considerable quantities in the alimentary canal, and are excreted by the kidneys; but, on this theory, it is difficult to explain the non-occurrence of rigors after lithotomy and other operations. More probably it is a pathological exaggeration of the normal shiver which is so frequent during and immediately after micturition, and which is so strongly marked in infants, female as well as male, in whom it may be conjectured the spinal cord is, relatively to the brain, more active than it is in adults. This would bring it into the class of neurotic fevers; and its more frequent occurrence, and its greater severity when a catheter is passed for the first time, and when a stricture is still young and irritable, would admit of easy explanation.

Other consequences that occur later are due either to mechanical injury, or to the products of septic or ammoniacal decomposition.

Hæmorrhage, for example, from laceration of the mucous membrane is not uncommon, and in cases of granular urethra or inflamed prostate is very difficult to avoid. In stricture especial care is required, as not unfrequently the mucous membrane is so softened from congestion that it gives way at once. If this occurs the catheter should be immediately withdrawn: the wound only makes the congestion worse, and diminishes by so much the chance of finding the orifice.

False passages are caused in the same way: they nearly always start either from the bulb or just in front of a stricture; there is a sense of resistance suddenly giving way, the patient complains of pain, and the catheter slips a little distance further, with an unmistakable sensation of grating.

Inflammatory affections of the urinary tract are still more common. All catheters, before using, must be thoroughly disinfected: it is not enough to dip them in carbolic oil of any strength. No part is exempt; *urethritis*, *perinæal abscess*, *prostatitis*, and *epididymitis*, may all occur; but by far the most common is *cystitis*. It is significant that ammoniacal decomposition of the urine often sets in for the first time within a week or two of the beginning of catheterisation.

In a few instances *synovitis* has been known to follow the passage of a catheter. Whether it is to be regarded as pyæmic in origin or as the result of reflex nerve-irritation is uncertain.

Treatment.—Local affections must be dealt with by themselves; so far as other complications are concerned, preventive treatment, by carefully preparing the patient and using the utmost gentleness, is the first consideration. Harrison speaks very highly of Fleming's tincture of aconite in two-minim doses for several days beforehand, and belladonna has been recommended. Sometimes, however, they will occur in spite of all precautions, and they cannot be prevented by anæsthetics.

The tendency to rigors may be checked, and if it is taken in time, as soon as the temperature begins to rise, actual shivering may certainly be shortened. A large cupful of hot tea should be given with five grains of quinine, twenty minims of laudanum (if the kidneys are sound), and half an ounce of brandy; and the patient should be well wrapped up and made to lie down at once; but, if it has once commenced, it is doubtful if it can be stopped altogether. If signs of acute renal congestion set in, the patient should be placed in a hot bath for a few minutes, and then well wrapped up in blankets; the bowels should be opened as soon as possible; and dry cups applied to the loins. If there is a catheter tied in, it must, of course, be removed at once. Digitalis may be given with advantage, a teaspoonful of the infusion every hour, until there is some effect on the circulation; or a linseed poultice may be made with the infusion, and applied, as hot as possible, to the skin over the loins.

When, on the other hand, the attack is insidious, as in old cases of stricture and enlarged prostate, and marked chiefly by wandering delirium and great prostration, active treatment is out of the question: the kidneys are already diseased; the bladder is in a state of partial atony, and has not been able to empty itself perhaps for years, and the patient's reserve of strength is almost exhausted already. Very little can be done beyond general measures: the patient must be kept warm in bed; the diet must be light and unstimulating; and the bowels kept slightly relaxed. Opium is positively injurious; stimulants, especially spirits, should be avoided as far as possible, but often they must be given; and sleep must be obtained by means of chloral and bromide. This condition may last for a week or ten days, and gradually pass away; or, especially when, owing to the state of the bladder, the catheter must be used, it may very soon terminate fatally. The pulse becomes quicker and feebler; the tongue is dry and brown; the delirium is more marked; the amount of urine secreted becomes less and less; the strength fails from hour to hour, and the patient sinks into a condition resembling typhoid.

A catheter occasionally requires to be tied in the urethra. This may be necessary where there has been great difficulty in passing a stricture, or when, owing to the presence of fistulæ or for other reasons, it is wished to drain the bladder and prevent urine passing along the urethra. In the former case the instrument should be secured so that the point lies just outside the bladder; in the latter, the end, of course, must lie in it, but even then a certain amount of urine will always find its way by the side. The catheter should if possible be a flexible one, and celluloid instruments are to be

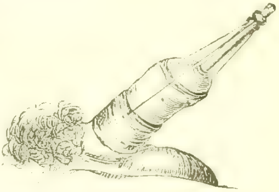
FIG. 445.—Mode of fastening catheter in the bladder.

preferred to others, as the urine does not decompose so readily. Even with them the instrument should never be left longer than three days without being changed. Many patients cannot stand the continued irritation; the catheter acts as a foreign body; inflammation soon commences, and in a very short time the urea decomposes and the end of the instrument becomes coated over with a layer of phosphates.

The simplest method is to pass two threads through the metal loops, one on either side, and fix them to the skin of the penis by a piece of strapping wound round it near its root. Or, as this plan has certain objections, and is not too secure, the threads (which must be double) may be knotted on either side about an inch and a half from the catheter; then, taking the two threads of one side, the one is carried over, the other under the penis, and knotted together on the opposite side so as to enclose it in a loop; the ends are tied to the pubic hair. The other pair is then to be treated in the same way.

A better plan still is to fasten a bandage round the abdomen, and to attach a long tape to it on either side; these are to loop round the thigh. The end of each is carried across the abdomen, round the outer side of the opposite limb, and then brought up by the side of the scrotum, so as to be fastened to the waist-belt again. The tapes from the catheter are tied, one on each side, to the band in the groin, just opposite the root of the penis, so that it can assume any position that is convenient without allowing the unstriped muscular fibre of the urethra to push the catheter out. Arnold's elastic holder is simpler and equally effective (fig. 446).

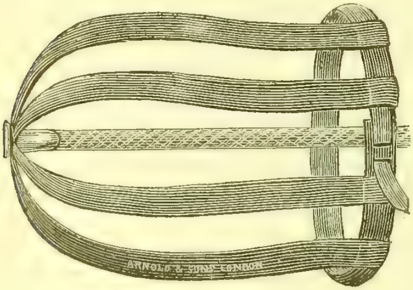

Fig. 446.—Arnold's elastic holder.

DISEASES OF THE URETHRA

Inflammation

Acute inflammation of the mucous membrane of the urethra is not common except as a result of gonorrhœa; mild forms of it, however, may be produced by other causes. Chronic inflammation may commence as such (as in the case of tubercular urethritis); or follow an acute attack which is prevented from subsiding by some constitutional or local cause, such as gout or stricture.

Causes.—1. *Mechanical injury:* the passage of sounds, for example, or the impaction of a calculus.

2. *Chemical irritants.*—These may be the product of a specific germ (gonococcus); or they may be present in foul septic discharges; or they may be excreted by the kidneys in the urine—e.g. cantharides and uric acid.

3. *Syphilis* and *tubercle.*

Acute Urethritis

The most intense form is gonorrhœa, an acute suppurative inflammation of the mucous membrane due to contagion, and probably to the presence of a specific germ. It always begins as a local disease, but sometimes the constitution becomes affected, and secondary troubles, peculiar to itself, make their appearance in distant parts of the body.

Gonorrhœa.—The germ (gonococcus) is found upon the surface of the epithelial cells in gonorrhœal pus, each individual coccus being placed at a distance equal to its own diameter from its fellows. It is stated to be always present, and to be found in the discharge of ophthalmia neonatorum, as well as in the fluid of gonorrhœal arthritis and conjunctivitis. Cultivations of it have been made in gelatine, and these are equally active. Vaginal discharges which do not contain the gonococcus can infect the urethra and even the conjunctiva, and cause inflammation; but it is rarely so severe, and it is stated that it is never followed by the peculiar sequelæ of gonorrhœa. This, however, is not proved. If they do occur after simple urethritis, the theory as to the specific origin of course breaks down; at least, there is no further need for it. Some of the difficulties may be explained by the fact that, particularly in women, gonorrhœa may remain latent for a very long period of time, so that infection with the true virus, which grows with great vigour when transplanted to a fresh soil, can occur without there being any reason to suspect more than leucorrhœa.

There is no doubt, however, that the action of the poison, whether it is a specific germ or not, is greatly favoured by different conditions. Certain people seem to enjoy immunity, or, if they are attacked, the inflammation is of the most transitory character. The first attack is usually by far the worst and, so far at least as out-patient practice is concerned, it is rare to see it very severe in anyone over five-and-twenty. Intense and prolonged sexual excitement, too frequent intercourse, and irritating conditions of the urine, such, for example, as that produced by the free use of alcohol, of themselves sometimes cause a mucopurulent discharge, and certainly they render the mucous membrane more sensitive. Asparagus and new sherry are stated to have a peculiarly strong influence in this direction.

Symptoms.—The period of incubation is short, from four days to a week. The first sign is a slight redness at the meatus with an increased secretion of mucus, a sense of soreness or itching, and a certain amount of smarting during micturition. In the course of the next two days these symptoms become more marked, and more and more of the urethra is involved, until the whole mucous membrane is in a state of the most intense inflammation. The meatus is swollen and red, the prepuce œdematous, the glans turgid and shining, and the whole penis enlarged and soft, with the veins congested and prominent. Sometimes red lines, due to the inflamed lymphatics, can be seen in the skin, and the glands in the groin, especially those just below Poupart's ligament at the inner end, are swollen and tender. At the same time the discharge increases until it flows away continuously, and its character changes from glairy mucus to thick, cream-coloured, yellow, and even, in severe cases, greenish pus.

Increased frequency of micturition occurs very early; at first it is probably reflex, but later it is due to extension of the inflammation towards the neck of the bladder; and each act is attended by a scalding, burning pain, partly caused by the tension on the mucous membrane, partly by the irritation of the acid urine. Sometimes, as the swelling and congestion increase, the stream is obstructed, and, if the prostate is attacked, retention is almost sure to occur. Malaise and fever are usually present during the acute stage, and at night, even when the penile part only is involved, rest is much disturbed by chordee. As the patient grows warm in his bed the penis is liable to become erect; owing to the infiltration in the corpus spongiosum, it cannot expand evenly, and the inflamed and tender fibrous tissue is stretched until it causes the most intense suffering. If the inflammation extends to the deeper part of the urethra, where it is fixed and surrounded by fibrous tissue, the pain is even more severe, and there may be high fever; the perinæum throbs and burns; there is a sense of weight in the pelvis, and a constant aching across the loins; and the skin over the scrotum and testes is sometimes so tender that the patient can scarcely endure being touched.

The acute stage lasts a week or ten days. As it begins to subside, the scalding becomes less intense; the throbbing ceases; the frequency of micturition disappears, and the discharge diminishes in quantity, loses its greenish colour, and becomes less thick. If no complication is present it may cease altogether in about six weeks; more frequently it persists for some time, not more than a few drops of glairy mucus in the twenty-four hours, or perhaps merely sufficient to glue the sides of the meatus together of a morning; but with every indiscretion, irregularity of diet, sexual excitement, undue exercise, or alcoholic indulgence, returning and becoming mucopurulent for a few days.

Sometimes it becomes chronic. The mucous membrane becomes rough and granular, covered with hypertrophied papillæ; or the loose and vascular tissue that surrounds it becomes dense and hard, as the lymph that fills its meshes is organised; in either case the change, slight as it is, is sufficient to maintain a certain degree of irritation; there is a constant discharge of thin mucus from the meatus (gleet), and more and more lymph is poured out until the diameter of the urethra is narrowed, and a stricture is formed which, itself an irritant, keeps up the inflammation, and continues to get firmer and firmer the longer it lasts.

Complications.—(*a*) *Hæmorrhage* is not uncommon, owing to the overloaded condition of the thin-walled vessels in the mucous membrane, but, unless very profuse, it need not excite alarm; the green colour of the pus is due to hæmoglobin. *Chordee* and *retention* have been already mentioned.

(*b*) The most common are caused by extension of the inflammation to structures near. *Balanitis*, *posthitis*, *phimosis*, and *paraphimosis* are of frequent occurrence; *warts* rarely occur until the irritation has lasted some length of time. *Abscesses* are not so often met with, but they occasionally originate in the mucous follicles, especially those of the fossa navicularis; or they may occur independently of the mucous membrane, in the lymph that is poured out around it. If the suppuration is in the region of the bulb, or on one side of it, in connection with Cowper's gland, it often spreads a considerable distance before coming to the surface. *Prostatitis*, with complete retention, and *cystitis* often follow; occasionally even the pelvis of the kidney and the peritoneum are involved. *Epididymitis*, from extension down the vas deferens, is not so common in the acute stage as later, when gleet sets in. *Bubo* and inflammation of the lymphatics may occur at any time, especially if the patient will not rest quiet; and even pyæmia may break out and prove fatal, starting, in all probability, from some ulceration of the mucous membrane.

(*c*) Others are caused by direct infection. Of these *conjunctivitis* is the best known and the most serious (*gonorrhœal ophthalmia* and *ophthalmia* *neonatorum*), but it is said that the mucous membrane of the nose and of the rectum may be attacked in the same way.

(*d*) Another variety is the result of constitutional infection, and does not occur, so it is said, in simple urethritis, however severe it may be. The fibrous tissues (particularly the joints) are the parts most liable to be attacked, but sometimes the sclerotic, the plantar fascia, the tunica albuginea of the testis, and the sheets of fibrous tissue in the loins suffer as well. Its connection with gonorrhœa is shown by the fact that not only does it return with each fresh attack, but that, if from any indiscretion there is a relapse or an increase in the amount of discharge, there is frequently at the same time a fresh outbreak of the secondary inflammation. When it is acute and attacks several joints, it may be distinguished from rheumatic fever by the absence of the sweating and the thick white furred tongue, and by the rarity with which cardiac complications occur; but the relation that it bears to gout, particularly to the chronic rheumatic form, is much more uncertain. There is no doubt that it is more likely to break out in those who are subject to this complaint, or in whose families there is a well-marked history of it; and I have seen several cases which strongly bear out Hutchinson's contention that, in patients who are distinctly gouty or rheumatic, any urethral discharge, specific or not, may give rise to symptoms similar to those of gonorrhœal rheumatism. Suppuration rarely occurs; but, if it does, it is impossible to draw a definite line between gonorrhœal arthritis and pyæmia. A similar affection occurs not unfrequently in women who are suffering from chronic leucorrhœa; and ophthalmia neonatorum, according to Lucas, may give rise to something of the same character. For a further description see Diseases of Joints.

Acute urethritis, of a similar description, but much less intense, may be caused by infection from leucorrhœal or menstrual discharges. When due to mechanical irritation, such as the passage of a catheter or the impaction of a calculus, it rarely lasts more than a day or two. If there is a stricture the discharge may be profuse at first, but it is rarely purulent; and, if the cause is removed, the symptoms soon subside. Occasionally, however, the inflammation extends, and epididymitis and other complications occur, as in gonorrhœa.

Gouty urethritis, like inflammation of the bladder, is not uncommon when the urine is loaded with uric acid. Usually it is an extension of the inflammation from the neck of the bladder, and the discharge is preceded for some days by irritability, increased frequency of micturition, and sharp, cutting pain at the end of the penis. It is most common in stoutly-built, middle-aged men, addicted to alcohol, but it is met with in women also; and a somewhat similar form, dependent upon mal-assimilation, and attended with a deposit of uric acid crystals, is not uncommon among poorly-fed children, and often gives rise to the suspicion of calculus. Unless it is the residue of a gonorrhœa kept up by the condition of the urine, it rarely happens that there is much discharge, or that it is purulent. Berkeley Hill has described a very obstinate form analogous to this, *eczematous urethritis*, occurring under much the same conditions, but associated with eczema of the skin. The surface of the glans is reddened and tender, and the anterior part of the urethra appears to be affected in the same way; the mucous membrane is bright red in colour, though it does not bleed easily, and the discharge is scanty and milk-white. Epididymitis, prostatitis, and other complications may occur in gouty urethritis as well as in the rest; but, in addition, inflammation may attack the joints, the eye, the testis, the fibrous tissue of the back, the sheaths of nerves, and the plantar fascia, just as in gonorrhœa; and unless the history, the condition of the patient, and the state of the urine are carefully investigated, it is very difficult to distinguish one from the other.

Tubercular urethritis is generally secondary to inflammation of the bladder, and the urethral symptoms are completely overshadowed by the intense irritability and the fearful burning pain at the neck when it contracts. The discharge is generally scanty in amount, and, unless the anterior part of the urethra is involved, is only seen when the urine washes it down, but it is often stained with blood coming from the surface of the ulcers when the muscles are contracting. The sense of smarting during micturition is sometimes very severe; and, owing to muscular spasm, is apt to continue for a long time after the act is finished; and the passage of a sound or catheter gives the most intense pain when the ulcers are reached. Cicatrisation sometimes occurs, and gives rise to stricture; but, as a rule, the bladder and other organs are involved, and the patient rarely lives long.

Syphilitic urethritis.—A scanty discharge, with a certain amount of soreness along the urethra, is not infrequent in early secondary syphilis, caused, in all probability, by the eruption of a few roseolous spots upon the mucous lining. As a rule it disappears very rapidly under specific treatment.

Treatment.—As gonorrhœa commences by infection at the meatus, it has often been proposed to cut short the attack as soon as the redness first makes its appearance by the use of a strong astringent, limited to the anterior part of the urethra. Tannin or nitrate of silver (gr. v ad ℥j) is generally recommended; and so long as the penis is carefully compressed immediately behind they may be used without danger, but it is doubtful whether they are of much service.

1. *The acute stage.*—Local applications are better avoided so long as the intense hyperæmia with profuse purulent discharge and the severe pain continue. The patient should, if possible, be kept in bed; the absolute rest obtained in this way is better than anything else. The bowels should be kept freely open, the diet carefully regulated, all forms of highly seasoned food and sauces, pepper, vinegar, tea, coffee, rhubarb, and asparagus being forbidden, and as much fluid (barley water, milk, &c.) allowed as the patient wishes; but no alcohol. Claret and very weak gin and water are perhaps the least injurious; champagne, sherry, and beer will often bring back a temporary gleet months after its last appearance. If the urine is acid and irritating, alkalies may be given with sedatives, such as hyoscyamus; but if the bicarbonates are used they should always be taken during digestion, not while the stomach is empty. The dressing of the penis itself should be light, and frequently changed; anything that prevents evaporation, or that absorbs the pus and dries upon the meatus so that the discharge cannot escape, is injurious. A soft linen bag in which it can hang freely, with some wood-wool at the bottom to soak up the discharge, is as convenient as anything. Dressings retained under the prepuce are liable to be very irritating; if the glans cannot be exposed it is better to introduce a soft rubber tube by the side of it as far as it will go, and irrigate its surface thoroughly several

times a day with lead lotion. The antiseptic treatment by means of bougies, though it promises well, is not so successful in practice.

If the hyperæmia is so great as to threaten retention of urine it may sometimes be checked by free leeching in the perinæum, or by the application of Leiter's coil, with ice-cold water. If it comes on in spite of this, a soft rubber catheter of moderate size must be passed, and, if necessary, this must be repeated three times a day. A morphia and belladonna suppository the last thing at night, or a hypodermic injection in the perinæum, will usually stop chordee. Bromide of potash in full doses is also very useful, and camphor is said to be of value. The patient should be directed to take a warm (not hot) sponge bath, at night, to avoid late meals, to get the bowels to act freely before retiring to rest, and to have only the lightest clothing on while in bed. Abscesses around or in connection with the urethra should be opened freely and as soon as possible, or they are liable to degenerate into troublesome sinuses. They are most common near the meatus, starting from the follicles in the fossa navicularis, or else forming by the side of the frænum; sometimes, however, they occur farther back in connection with Cowper's glands. They may burst into the urethra, but unless there is a stricture present it seldom happens that the fistulous opening persists.

2. *The subacute stage.*—When the active hyperæmia and scalding have subsided, or if the inflammation is only subacute from the first, more active measures may be adopted. Copaiba and cubebs may now be given with advantage; or if they do not agree with the patient, gurjun, sandal-wood, or eucalyptus oil. These all appear to act locally, the resin being excreted by the walls of the urinary passages. Copaiba, when it can be tolerated, is perhaps the most efficacious; half-drachm doses may be given, rubbed up with burnt magnesia in the form of a bolus, or with sulphuric acid, or better still, if the patient will take it, with liquor potassæ, with which it forms a kind of soap. Harrison has shown that it is much more effectual when given with an alkali than in the form of capsules. Cubebs are more stimulating, and may be taken with it. The best time for administration is either an hour before meals or three hours after. In some patients, however, copaiba produces a characteristic roseolous and even papular eruption upon the skin (copaiba rash); in others it disturbs digestion to such an extent that it cannot be endured; and it even has the credit of causing hæmaturia. Few can stand it for any length of time, and if it does not produce a definite improvement in the course of a fortnight, it is better to stop it altogether. Such patients are often more benefited by tonics.

In the majority of instances, gonorrhœa will get well without the use of injections; but in the subacute stage, when the discharge shows no signs of abating, and still more when a chronic gleet has set in, they may be used with advantage. So long as there is extreme hyperæmia they are positively harmful. The ordinary glass syringe is useless, unless the mischief is confined to the fossa navicularis; the object is to wash out the discharge from off the mucous membrane, so that it may not remain stagnant in its folds or recesses, and to apply a very mild astringent to the surface. Durham's tube, which can be introduced as far as the bulb, and which is provided with openings so that there shall be a recurrent stream, is the best, but in its absence a small flexible rubber catheter may be employed. This should be introduced as far as necessary, and then connected with a Higginson's syringe. Hot water may be used first to wash out the urethra and then a very mild astringent. There is no fear of any injection penetrating as far as the bladder, if ordinary precautions are taken, and it should never be sufficiently strong to do any harm if it does. Chloride of zinc (gr. ss. ad ℥j), sulphate of zinc (gr. j ad ℥j), acetate of lead (gr. ij ad ℥j), tannin, mercuric chloride, subnitrate of bismuth (not suspended in mucilage), and many others are of use; and very often it is of advantage to change from one to the other. The bulb and the fossa navicularis may be thoroughly douched in this way every night, or, if no progress is made, night and morning; the application causes a certain amount of smarting, but if it is really painful, either the injection is too strong or the inflammation still too acute.

In tubercular urethritis everything must be done to maintain the strength of the patient and assuage as far as possible, by morphia and belladonna, the irritability of the bladder. If the urine becomes ammoniacal, relief may be obtained by opening the bladder in the perinæum and draining it. Iodoform seems to be the best local application, as in tubercular cystitis. Local applications are rarely of service when urethritis is due to gout; the urine must be rendered as unirritating as possible, the bowels kept open with mercurial purges, and careful attention paid to diet and exercise. When the urethritis is simply caused by the irritation of the urine it can easily be cured; but if there is gouty inflammation of the corpus spongiosum or of the prostate, the condition is exceedingly obstinate, and epididymitis and other sequelæ are not unlikely.

Chronic Urethritis

Chronic urethritis rarely occurs unless there has been an acute attack; the inflammation subsides up to a certain point, and then from some cause, local or constitutional, becomes stationary, the discharge persisting as a gleet, sometimes disappearing for a few days, and then returning again almost as bad as ever. Even in healthy persons, the mucous membrane of the urethra is always peculiarly sensitive after an acute attack; the least indiscretion for months after brings back a certain amount of gleet; and a very slight cause is sufficient to keep the irritation up permanently. Chronic inflammation of this description is the main cause of stricture; for months, and even years, minute quantities of lymph are constantly being poured out into the mucous and submucous tissues; as it becomes organised, it gradually renders them so dense and hard that at length a definite organic obstruction is developed.

The reason is often very difficult to find. Sometimes it appears to be due to general debility rather than anything else; the patient's health gives way; the mucous membrane remains soft and relaxed, without any great local change, and the catarrh becomes chronic, as it occasionally does in other parts of the body. In other cases it may be traced to errors in diet or to faulty modes of living. More frequently it is dependent upon some local affection, very slight, perhaps, but quite sufficient to keep up irritation. Small warts, similar to those on the prepuce and behind the glans, can be seen sometimes just inside the meatus. Pouches and dilatations of the mucous membrane, possibly originating from inflamed follicles, are found occasionally, especially in the fossa navicularis and in the region of the bulb. These serve to collect a small quantity of urine, which begins to decompose and act as an irritant before it is washed away. Chronic inflammation of

Cowper's glands sometimes occurs in the same way. A granular condition of the surface is still more common, especially in the region of the bulb. It closely resembles in appearance that which is left after repeated attacks of conjunctivitis ; the mucous membrane is rough and tender when touched ; the colour is bright red ; and it is covered with small papillæ. Slight strictures, again, are occasionally the cause ; the exudation of lymph is not sufficient to affect the stream, but for all that it renders the mucous membrane hard and unyielding, so that it cannot unfold itself as the urine is passing. Finally, in some cases, the whole of the urethra in front of the triangular ligament continues to secrete a profuse mucopurulent fluid, without its being possible to find any local or constitutional cause to account for it. Harrison has described several such, in which the passage appears to have degenerated into a chronic suppurating sinus, which could not be drained, and which, in spite of injections, and in one case of internal urethrotomy, declined to improve in any way. At last they were cured by giving the urethra perfect rest for a month, opening it behind in the perinæum, and draining off all the urine from the bladder, so that no drop should flow along it.

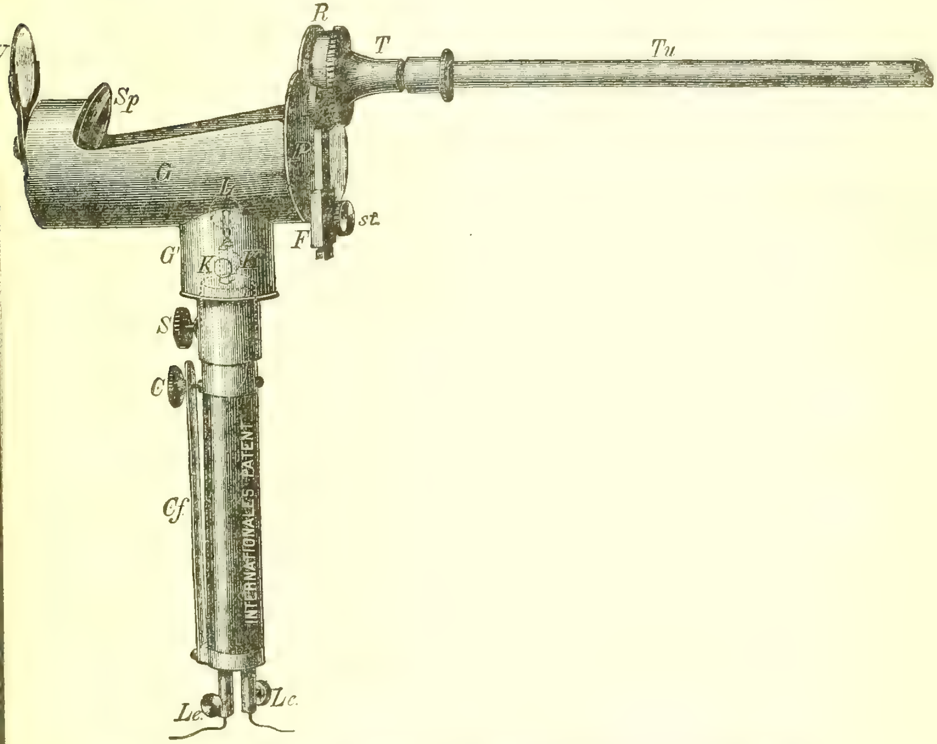

FIG. 447.—Leiter's panelectroscope, from Schall's catalogue. *L*, lamp ; *Sp*, mirror *V*, lens for correcting any defect in the observer's vision.

An absolute diagnosis in such cases can only be made by means of an endoscope. Leiter's panelectroscope is perhaps the most convenient : it carries a small incandescent lamp in the vertical portion, so arranged that its rays are concentrated by a mirror and reflected down the tube, while the observer's eye looks over the upper edge. It is an additional advantage that, with this instrument, applications may be made to any part of the urethra that requires them, without withdrawing the tube.

Constitutional treatment should be thoroughly tried. If the patient is broken down in health and strength, tonics and sea-air often prove efficacious; or, if there is evidence of gout, alkalies may be given, or the patient may be sent for a time to Bath or Homburg, so that the mode of life may undergo a complete change. The diet should, in all cases, be carefully regulated, especially as regards the amount of alcohol; and, according to some, smoking is particularly injurious. At the same time, the deeper part of the urethra should be thoroughly washed out with some mild astringent, as in chronic gonorrhœa, only this should be done, not once a day, but after each act of micturition. It is no use injecting the meatus unless it is known there is a tender spot in the fossa navicularis; the only method is to pass a soft rubber tube down as far as the bulb, and with Higginson's syringe gently douche the whole length from behind, varying the nature of the application every week or ten days. If this does not succeed, a full-sized bulbous instrument should be slowly and carefully passed, and then after the spasm has subsided, withdrawn again. Sometimes this of itself is sufficient: the muscular fibre of the urethra is stretched; the spasm ceases for a time; the mucous membrane gets a certain amount of rest, and the irritation has a chance of subsiding. The same treatment is often successful in obstinate cases of neuralgia, which persist without anything being found to account for them.

Most frequently, however, the persistence of the symptoms is due to some local change in the mucous membrane, which requires special treatment. The method, of course, must vary with the lesion; small warts in the meatus may be snipped off or touched with mild caustics; if the mucous membrane is rough and granular, a moderately strong astringent may be applied to the surface by means of a syringe, as in chronic prostatitis. Glycerine and tannic acid I have found very useful to commence with; if this fails, nitrate of silver (gr. v ad ℥j) may be tried. Sinuses should be distended with a similar injection, after each act of micturition, or, if near the meatus, they may sometimes be laid open. There is a congenital diverticulum occasionally present in the fossa navicularis, which rarely gets well until it is treated in this way. Its existence may be suspected when there is a feeling of pain in the glans at the commencement of micturition, or when squeezing the glans suddenly sometimes causes a few drops of discharge to make their appearance; but, as its opening lies towards the bladder, it can only be detected with the endoscope, or with a probe, the point of which is bent back upon itself. Finally, if there is any resistance to the passage of a sound, especially as it is being withdrawn, suggesting the presence of a commencing stricture, a full-sized instrument should be passed once a week, until it is no longer grasped.

STRICTURE

Stricture of the urethra may be congenital or acquired. The former is very rare and only occurs at the meatus, or within a short distance of it; the latter is met with in every part except the prostatic, and is always the result of inflammation.

Stricture, in the true sense of the term, must be a structural alteration in the wall of the urethra; there may be only a certain degree of roughness and unevenness, so that the mucous membrane does not unfold itself smoothly when urine is passing; or thickening and exudation in the submucous tissue, leaving the surface smooth; but in every case there is a definite and persisting change. Spasm and congestion are always present in addition, owing to the vascularity of the part and to the amount of unstriped muscular fibre, especially in the region of the bulb; and in certain conditions (such as congestion of the prostate) these of themselves are sufficient to cause obstruction and retention; but they are in reality symptoms, not diseases, and it is better to reserve the term stricture for an organic change.

Causes.—*Gonorrhœa* is by far the most common, A slight attack merely leaves the surface tender with enlarged hypertrophied papillæ; when it is more severe and long continued, a large amount of exudation is poured out into the submucous tissue; and gradually, as it becomes organised, it constricts the canal more and more. Ulceration of the surface and cicatrisation are rare.

Injury.—Rupture of the urethra may cause stricture of a very obstinate character if suppuration occurs, owing to the dense mass of cicatricial tissue formed. Impaction of a calculus, median lithotomy, when the urethra is torn, and caustics are occasional causes.

Syphilis.—Primary sores not unfrequently cause stricture at the orifice; and occasionally, in the later stages, ulceration of the mucous membrane or gummatous exudation into the corpus spongiosum, leads to the same result. A few instances are on record in which stricture has followed tubercular ulceration.

Many different terms are used to describe strictures, according to the prominence of special features. If there is a band of lymph stretching across the canal from side to side, it is called a *bridle*; when there is a thickening round the whole circumference, as if a piece of string were tied around it, it is *annular*; and if the base is much infiltrated, *indurated*. Sometimes, especially in old cases where there are fistulæ, this is so hard and extensive that the stricture is said to be *cartilaginous*. Those are *irritable* where rigors occur whenever a catheter is passed; and *resilient* or *elastic* if the constriction returns at once after dilatation. Very often they are *tortuous*; and sometimes, but probably only when the wall of the urethra has sloughed, they are *impermeable*.

So far as concerns the question of treatment, the most important distinctions are the locality (whether near the meatus or deep down in the bulbous part), the length of time the stricture has been there, and the amount of induration. If recent, the infiltration is slight, and the lymph to a great extent still soft and cellular; in older cases, those for instance of some years' duration, an inch or more of the wall of the urethra may be converted into a dense cicatricial mass, extending into the corpus spongiosum, and feeling from the outside as hard and resistant as cartilage.

Locality.—Stricture never occurs in the prostatic portion of the urethra. The most common situation is said to be at the bulb, though in a very large number of instances it is really in front of this. Various reasons have been offered in explanation. Some consider it due to this portion of the urethra being horizontal when the body is erect; the discharge does not flow away, and, acting as an irritant to the mucous membrane, causes a greater amount of lymph to be poured out here than elsewhere. Others have assigned it to the angle that the penis forms in front of this spot, so that the walls are pressed closely together. Probably the real reason is the unusual amount and the looseness of the mucous and submucous tissues allowing a larger quantity of lymph to collect. The urethra is only patent for the moment that the urine is passing along it; except at this instant, its walls are in contact and thrown into longitudinal or spiral folds. If it becomes inflamed, these are thickened, swollen, and pressed together; and if the lymph that is poured out is allowed to become organised, the canal is permanently narrowed.

When traumatic, the seat of the stricture depends naturally upon the injury. Usually the urethra is torn a little in front of the membranous part or just where this joins the bulb. Those due to venereal sores are nearly always at or close to the meatus.

In most instances stricture is single, but it is not uncommon to find two or even more, and in a few cases as many as six distinct ones have been described as existing at the same time.

Pathology.—*Post mortem* a stricture appears as a contraction of part of the urethra. Sometimes, especially when near the meatus, there is a band stretching across from one wall to the other, or a distinct cicatrix on the sides; more frequently there is an opaque white constriction, extending around the whole circumference, dense and indurated, and varying in thickness in different parts, so that the canal is narrowed, tortuous, and irregular. In many cases the mucous membrane is affected equally with the submucous tissue, its elasticity is entirely gone, and it is fixed firmly; but sometimes it can be dissected off, and opened out to its full extent, almost unaltered. On the other hand, in old cases, especially in the region of the bulb, the mucous and submucous coats, the corpus spongiosum, and even the areolar tissue outside, are converted into a gristly cartilaginous mass, in which scarcely a trace of any of the original structures can be found.

In front of the stricture the mucous membrane is swollen, reddened, and hyperæmic, ready to bleed at the least touch, and the unstriped, muscular fibre is in a state of tonic contraction; but this, of course, disappears *post mortem.* The surface, however, is rough and irregular with small granulations; usually it is discoloured from old hæmorrhages; or it is excoriated or covered over with mucus, and the normal folds of the urethra are confused and sometimes altogether lost.

Behind, the effect upon the other organs is soon apparent. Owing to the increase in the pressure, the urethra becomes dilated; the orifices of the small ducts enlarge; some of the bands of muscular fibre increase in size, leaving between them depressions in the thinned and stretched mucous membrane, similar to those found in the bladder, only on a much smaller scale; and at length the interior may become reticulated or studded with little pouches which act as receptacles for decomposing urine. Then the bladder becomes affected. If the obstruction is sudden and extreme from the first, too great for the muscular coat to overcome, it yields and becomes atrophied, the cavity enlarges, and the walls become thin and soft. If, on the other hand, the resistance is of slow formation, so that the work increases gradually, and if there is any irritation, so that the bladder is constantly contracting, the opposite effect is produced—at first, at any rate: the wall grows thick and rigid; the cavity diminishes in size; the muscular coat hypertrophies; and the fasciculi stand out under the mucous membrane in ridges, like the musculi pectinati of an auricle, leaving between them deep depressions. As time passes, these changes become more and more marked: each time the bladder contracts the urine is driven into the depression between the ridges, until they become deep enough to project on the outside under the serous covering; and then they soon enlarge into *tunicary herniæ or sacculi.* There is no muscular fibre in their wall; they cannot resist or empty themselves; with each contraction the urine is driven into them, distending them in all directions; and not unfrequently they become almost as large as the bladder itself, with which they communicate by a very narrow opening (fig. 411). The same influence is felt by the ureters and the pelvis of the kidneys; there is no regurgitation, but owing to the great increase in the pressure, they become more and more distended, at the expense of the glandular part, until, in the case of the kidneys, the secreting power is seriously impaired.

The effect, however, is rarely limited to mechanical dilatation. I have known cases in which, though the bladder was distended to the umbilicus, and though it had been in that condition for months and even years, the urine on being drawn off was normal and acid; but this is the exception. Inflammation nearly always breaks out sooner or later, probably extending upwards from the stricture. Ulceration may then set in behind, in the dilated part of the urethra, and lead to extravasation of urine; an abscess may form in the substance of the stricture tissue, and burst in the perinæum, leaving behind it a fistulous opening; suppuration may occur around the prostate; or the inflammation may spread down the vas deferens to the testes.

The bladder is usually the first involved, but the ureters and kidneys follow suit very soon. At first there is merely catarrhal cystitis and pyelitis, but when the urine becomes more irritating, and especially when it decomposes, the effect is much more marked. The mucous membrane becomes ulcerated and coated with phosphatic débris; the pus spreads along the connective tissue in the substance of the kidney; numbers of minute abscesses form under the capsule and in the cortex; the apices of the pyramids are destroyed; and at length the kidney is almost disorganised; it is reduced in size, hard, and irregular on the surface, from old interstitial inflammation; the capsule is adherent; when it is stripped off there are numbers of little abscesses beneath; and the pelvis is enlarged, irregular in shape, blackened and ulcerated on the surface, and filled with a mixture of stinking pus and phosphatic débris.

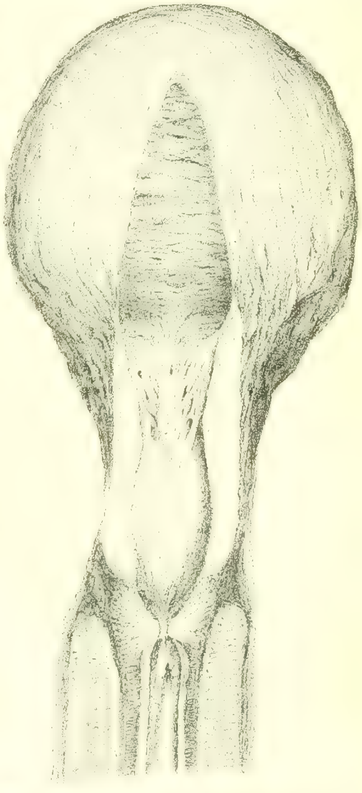
Fig. 448.—Stricture of urethra, showing fasciculated and contracted bladder; dilated prostatic urethra with reticulations consequent upon distension of the prostatic follicles; ulceration above the stricture, and orifice of false passage below.

Symptoms. (*a*) *Those due to the obstruction.*—Complete retention is sometimes almost the first. In recent strictures the urethra is often peculiarly sensitive; spasm and congestion may be caused by the slightest irritants and close the channel altogether, even though the opening is still fairly wide. More frequently the outflow is merely impeded. Simple twisting or flattening of the stream may be due to the shape of the meatus, and means nothing; but if it is forked or much reduced in size or force it is very suggestive. In old cases, when the obstruction becomes very great, the stream may fail completely, the urine only coming in drops. Generally, after micturition is finished, the last few drops flow away of themselves, owing to the action of the urethral muscles being interfered with; but this happens also in enlargement of the prostate, and even after exposure to cold.

(*b*) *Those due to inflammation*—Usually there is a slight mucopurulent discharge (gleet), especially of a morning, or after exercise. In general it is only a drop or two, and many patients are unaware of its existence, but it may cause great annoyance. Pain is seldom felt, unless there is some inflammatory complication, or the urethra is forcibly distended. In cases of long standing there is usually thickening about the corpus spongiosum or the bulb. Spasm is rarely wanting, and often leads, especially in recent strictures, to complete retention. As they grow old and cartilaginous, either the muscle loses its power or the surface its sensibility; but in this there is a strong personal element, and the urethra is much more sensitive, especially when inflamed, in some than in others. Any slight irritant, an excess of uric acid for example, alcohol, sexual indulgence, exposure to cold or wet, constipation, or even an inflamed pile, may set up sufficient spasm to render the closure complete.

This is of great consequence in relieving retention due to stricture. If a catheter cannot be passed at once, teasing the stricture only makes the spasm and congestion worse; while relief (for a time, until more efficient measures can be adopted), can almost always be obtained by hot baths and other measures that procure muscular relaxation.

The course of stricture, if left to itself, is simply from bad to worse. Temperament and the position of the stricture are of some influence: deep ones, that is to say, are worse than those near the meatus; but the chief element in prognosis is the condition of the kidneys. As the bladder becomes involved, micturition becomes more frequent and the straining greater; the patient has to rise at night; retention is always liable to occur; at first it may be relieved with an instrument or baths and purgatives, but each time it leaves a permanent change for the worse; pain becomes a more prominent feature; there is a constant dull, aching pain in the loins; and rupture, hæmorrhoids, and other troubles follow. Then the kidneys become affected: the specific gravity of the urine diminishes; the amount of solids is lessened; the patient grows weak and anæmic; digestion fails; chills and feverish attacks are of common occurrence; the skin becomes harsh and dry, and the health breaks down completely. Urinary abscess is of common occurrence: extravasation may take place; calculi may form; inflammatory troubles of all kinds may follow; or, if none of these things happen, the quantity as well as the quality of the urine diminishes; the albuminuria becomes more pronounced; and death is caused either by urethral fever and suppression, or more frequently by some intercurrent disorder, such as pneumonia or pleurisy.

Diagnosis.—The diagnosis of stricture can only be made by sight or touch. With the exception of those at the meatus, either an endoscope or a sound must be employed. Each has its separate uses; one cannot replace the other. As most patients do not apply for relief until the narrowing of the canal is advanced, the sound is of greater service; but in earlier cases, where there is little organic change, and where the symptoms are mainly due to spasm and congestion, the endoscope tells much more. With the one it is only possible to say that there is a tender spot in the wall of the urethra, giving rise to spasm, congestion, and pain; with the other, the size, locality, and nature of the lesion can be accurately determined, in most cases with the greatest ease.

For diagnosis, metal sounds are preferable to flexible ones; the information they give is more precise. For treatment this does not hold good; a soft flexible instrument can often find its way along the folds of the mucous membrane into the orifice of a stricture, while a rigid one becomes entangled at once. The best are of steel, as this takes a higher polish and the curve should be short and abrupt. The smaller sizes may be of the same diameter throughout, but in the case of the larger ones the shaft is slender, so that it may move freely in the urethra, and the end expanded like a bulb. This may be either conical or ovoid; the former are used for ascertaining the length of a stricture, the conical shape passing readily through the narrowed part; on being withdrawn the shoulder catches at once. Unfortunately English sizes are so arbitrary that it is scarcely possible to be accurate with them; the smallest is usually about one-fifth of an inch in circumference, the largest (No. 12) nearly an inch. The French, on the other hand, are graduated accurately from one millimetre in circumference up to forty.

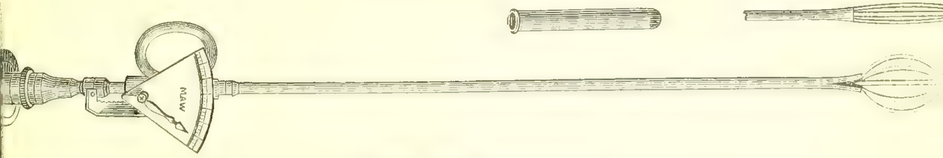

FIG. 449.—Otis' urethrameter.

The size of the urethra.—There is a distinction between the normal diameter of the urethra during life and the size to which it can be stretched without injury. Even when urine is passing in full stream the walls are contracted and maintain a certain degree of tonic pressure upon it so as to ensure its ejection; and they can be stretched, so far at least as the penile part is concerned, far beyond this. If a stricture is to be considered cured, it must be dilated until its width is as great as that of the adjacent part of the urethra when distended to its utmost. Clearly, if it contracts again, it will close much sooner if it has been dilated to No. 12 English than if it has been dilated to No. 16. But this is not all: if it is in a part which can be distended more widely (even though its diameter is equal to that of the rest when urine is passing), it remains an obstruction still; the walls are hard and rigid instead of being soft and flexible, and they must be stretched until the induration is gone and the lining membrane falls into its natural folds again. How wide this may be differs in each part, and probably in each person; and the only way to ascertain it is, either by carefully exploring with bullet sounds of different sizes (enlarging the meatus if necessary to admit them), or by measuring it directly with a urethrameter. The most convenient form of this instrument is that invented by Otis; it consists of a straight shaft, carrying at its end a small expanding bulb. The size of this can be increased or diminished by means of a screw near the handle. The measurement is recorded on a gauge.

The relation described by Otis between the size of the penis and that of the urethra only holds good in a limited number of cases; and a stricture dilated to No. 12 E. may be cured in one person, while in another No. 18 E. is not too large.

The meatus varies from a mere pinhole to the size of No. 16 E. (30 mm. F.); very often it is the narrowest part, and it never dilates readily. The fossa navicularis, on the other hand, is fairly wide, and can be enlarged without difficulty. After this the canal is narrow again, the diameter slowly increasing as the bulb is approached; but the mucous membrane is so abundant and the tissues around so soft, that in most cases No. 16 E. (30 F.) and even No. 18 E. (34 F.) will pass with very little pressure and without any hæmorrhage. At the membranous part again there is a very sudden constriction; but here the structures around the canal are so rigid and unyielding that it can rarely be dilated beyond No. 12, or at the utmost No. 13 E.; and very often instruments of this size only pass with considerable pain. After this in the prostatic portion the distensibility increases to such an extent that the forefinger (if an opening is made in the perinæum) can be passed through it without difficulty, and without lacerating the mucous membrane.

There are certain consequences which not uncommonly follow the introduction of a bougie or catheter; and, so far at least as most of them are concerned, the liability to their occurrence is distinctly greater when a stricture is present, especially if it is recent and the mucous membrane is soft, hyperæmic, and over-sensitive. In old cases, or where a catheter has been repeatedly passed, it may be conjectured that the nerve-endings have to a great extent lost their sensibility.

Most of these have been already mentioned; some are due to mechanical violence (hæmorrhages and false passages, for example); others to inflammation, affecting the urethra, bladder, or prostate; and others again to the influence upon the nerve-centres. Of these the most important are atony of the bladder muscle, leading to retention; paralysis of the vasomotor nerves of the kidney, causing hæmaturia, or suppression; syncope; shock; rigors, and urethral fever in its various forms.

The same precautions should be used in exploring the urethra with a sound as in passing a catheter. The patient should be prepared in the same way and the same method adopted; but as the object is not to get into the bladder with the least friction, but to ascertain what sources of friction there are in the urethra, anæsthetics and cocaine are not advisable.

Method of exploration.—As a rule it is best to commence with a sound of moderate size, No. 8 or No. 9 E. (15 to 17 F.); if this passes smoothly and easily along the mucous membrane, stretching out the folds without meeting with any resistance, a larger one, No. 11 E. (20 or 21 F.) may be tried; and if this is equally successful, it may be concluded that there is no serious degree of contraction.

More frequently the instrument is grasped and held as soon as the point passes the fossa navicularis. The unstriped muscular fibre slowly contracts upon it, holds it fast for a minute or two, and then gradually tires itself out and releases it again. For this reason bulbous sounds with a comparatively slender shaft are more useful for exploring than those of which the diameter is the same throughout; with the former the enlargement only is held, and the degree of resistance in different parts of the canal can be appreciated; with the latter the shaft is grasped with as much tenacity as the end, and the delicacy of touch is to a great extent lost.

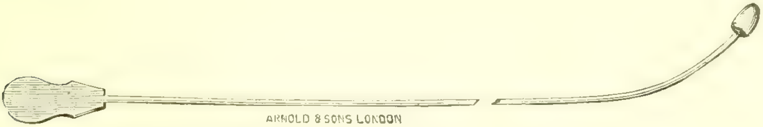

FIG. 450.—Bulbous sound for diagnosis.

This occurs even when the urethra is perfectly healthy, especially if a catheter is being passed for the first time, or if the patient suffers from gout or from highly acid urine; the instrument is firmly grasped the whole way down. Very often a second sound several sizes longer can be passed more easily than the first. If, however, before the membranous part is reached, there is one spot more sensitive than the rest, or if, after passing easily for an inch or two, the sound is suddenly arrested and held for a time, and perhaps is stopped again a little farther on (especially at the bulb, for the muscular coat is thickest there), there is probably some local affection, not sufficient of itself to cause distinct narrowing of the canal, but quite enough to render it tender and sensitive when touched, and to make the muscular fibre of the deeper part of the urethra involuntarily contract upon the offending body and bar its further progress. In the bulbous part this is not unusual; and if the front portion of the urethra is not examined with sufficient care the mistake may be made of imagining that there is an organic stricture deep down, while the real cause is some superficial lesion, a mass of granulations perhaps, or a little inflammatory thickening near the orifice. Examination with the endoscope under an anæsthetic usually reveals at once the true state of things; unlike an organic or true stricture, the obstruction disappears completely as the mucous membrane becomes insensitive, even with cocaine; the largest tube then that the meatus will admit can be inserted without the least pain, and an accurate diagnosis made, both as to the seat and the nature of the lesion.

When there is a definite organic stricture the sound is either stopped abruptly, or, if the spasmodic contraction relapses sufficiently to allow it to pass, the surface feels rough and irregular. The situation of the stricture, its size and length, and whether it is the only one present, must next be ascertained. Smaller sounds must be used for this, until one will pass; but now, as the object is not to ascertain the presence of a stricture, but to find out how wide it is, flexible instruments, which will find the easiest path for themselves, are better than rigid ones. The length can only be ascertained by passing through the stricture a sound with the shaft graduated in inches, and a conical bulb at the end; as this is drawn out, the base of the cone catches against the edge of the stricture and marks the farthest limit. Great care, however, is necessary for this. Recent strictures are easily displaced, owing to the looseness of the submucous tissue; and if the shaft of the sound is too flexible, or if it is not held in the axis of the canal, it is easy to manufacture a stricture at any point; as the bulb is withdrawn, it throws the mucous membrane of the urethra into little transverse wrinkles, over which it slips with almost the same sensation as over a definite fibrous ring. Deeper strictures of course can only be found out when they are narrower than the superficial ones.

Treatment.—The object in treating stricture is not merely to dilate that portion of the urethra to its full dimensions, but to prevent it narrowing again. The first is usually easy; the second exceedingly difficult, as the lymph thrown out resembles scar-tissue in its tendency to contract; but as cicatrices differ in this respect, according to their cause, those due to burns being the worst, so it is claimed for some of the methods used that they either insert in the stricture, as it were, a splice of material less prone to contract, or even cause the disappearance of the cicatricial tissue itself.

General.—The first thing in all cases is to allay as far as possible the spasm and congestion that are nearly always present. In cartilaginous strictures, it is true, they are not of so much importance; but in recent cases, of only a year or two's duration, they are not unfrequently the main obstruction. It is a very common thing to find that a stricture which at first appears almost impassable, after a few days' rest in bed under proper treatment, allows a No. 4, or even No. 5, English to slip through with ease.

When the attack is recent and acute, accompanied by retention of urine, this demands the first consideration. Either a catheter must be passed at once, or the patient must be placed in a hot bath, the bowels opened as soon as possible, and, if the condition of the kidneys is such as to allow it, a full dose of opium given. Where the case is not so urgent a great deal may be done by attention to general treatment: the diet should be light and unstimulating; the bowels kept well open; and if the urine is very acid, or if there is a large amount of urates, the liver should be made to act thoroughly. Alkalies and hyoscyamus are of the greatest use; opium, if required, should be given in the form of a suppository. No stimulants should be allowed; the patient should have a warm bath every night; and, if he is not kept in bed or confined to his room, care should be taken that his clothing is warm, and that he is not in any way exposed to cold.

Irritability of the urethra and spasmodic obstruction, provided there is no organic change, usually disappear in a very short time, and a catheter slips in readily and without pain. If the spasm persists, the urethra may be stretched every second or third day by passing a full-sized bougie as far as the bulb, and leaving it until it is no longer grasped. At first the disturbance is often a little increased, but, provided there is nothing local to keep up the spasm, this rarely fails. If it does, the endoscope usually reveals some cause, such as a small mass of granulations, or a slight roughness of the mucous membrane in the anterior part of the urethra, which will not get well without local treatment.

Local.—There are five chief methods of treating stricture—dilatation, rupture, incision, excision, and electrolysis. Of these, the first three are the most important, and each of them is capable of being carried out in various different ways.

1. *Dilatation.*—This may be either interrupted or continuous. In the former instruments are passed every two or three days, but are not left in; they are simply introduced and withdrawn again; three or four sizes may be passed at each sitting, but none should be so large as to be tightly grasped by the stricture; and each time it is as well to commence, not with the largest

used on the previous occasion, but with one a size smaller. In the latter an instrument is passed and left in, so that the end only lies just at the neck of the bladder. The principle in the two is somewhat different; the former relies merely on mechanical means; in the latter the instrument sets up a certain amount of irritation, which must have some effect upon the stricture tissue, for the dilatation succeeds as well with a small sound as with a large one. Indeed, if the instrument fits the stricture tightly, it is very likely to set up so great a disturbance as to require the treatment to be stopped for a time.

(*a*) *Interrupted dilatation.*—The instruments used for this purpose may be either catheters or bougies: the former have the advantage of allowing a drop of urine to flow away, and of showing that the bladder has been successfully reached; but against this there is the serious objection that, especially in the case of the smaller sizes, they are more inclined to break, owing to the eye, and also that it is not so easy to ensure absolute cleanliness. Soft ones should always be preferred to rigid: if the stricture is of wide calibre, they pass just as well; if it is small, they find their way, if they are properly made, infinitely better. A small metal instrument may be guided by the hand more easily, it is true; but the point is as sharp as a needle, and unless it is held with the lightest touch, it is sure to perforate the mucous membrane, and either make a false passage or else convert an annular stricture into a bridle.

The bougies in common use are of various kinds. The English or gum-elastic are made of woven silk, coated with copal varnish, so that they retain, to some extent, when cold, the shape given them when heated. These are of the same circumference the whole way down. The French or black bougies are made of the same material, but are much more flexible, and of different shape. Some little distance from the point the instrument tapers gradually until it becomes exceedingly pliant; the point itself is either left unguarded, or, in the olivary bougies, is expanded into a small bulb supported upon a slender neck. Genuine French bougies are as flexible as india-rubber tubing, and if the bulb touches anything the neck bends at once. English black ones are stiffer, the neck especially is not so pliant, the bulb is usually too large, and, as soon as any pressure is made upon it, instead of the curve being limited to the neck, it involves a fourth of the length. The smaller sizes must be carefully examined to see that the varnish is not cracked at the neck; there is not so much danger as in the case of catheters, but it is not uncommon for the bulb to break off suddenly, and this might easily happen in the urethra with very serious results. Sometimes the shaft is made rigid by weaving it round a metal stylet, so that the instrument can be bent to any shape. For very narrow strictures bougies are made of whalebone, catgut, or silkworm gut. The first-named is too rigid, even when softened in boiling water, to be of much service. Catgut is more useful, but it soon grows soft in the urethra, and then bends upon itself. Silk-worm gut is employed where bougies of moderate length and great tenuity are required. Some of these should be straight, others bent or twisted a little at the point, so that if the orifice is not found at once, the whole face of the stricture may be explored systematically, one part after the other, by merely twisting the instrument between the finger and thumb.

Besides these there are many contrivances for special occasions or for very narrow and tortuous strictures. Harrison's whip-like bougies are about two feet long, very thin, and tapering to a fine point at the end. If this slips through the stricture, the thicker part will follow, and coil up in the bladder out of the way. Then it may either be left in to dilate the stricture, the urine passing by the side of it, or it may be used as a guide or pilot for a railroad or tunnelled catheter (*i.e.* one with an opening at the end instead of the side), or for the hollow staff of a Maisonneuve-Teevan urethrotome. Sometimes a silver tube, open at both ends, is of help; it should be about six inches long, and as large as the meatus will admit. This may be passed down to the face of the stricture, and then filled with a number of filiform bougies; if these are tried one after the other, occasionally one will slip in. An instrument known as a path-finder is further elaborated from this: it consists of a straight tube (20mm. F. in diameter), the end of which is closed by a disc which can be made to revolve. In the disc is a small perforation through which a filiform bougie passes, and as the disc rotates this is carried successively all round the stricture, until at length the orifice is found. The endoscope answers better still: if the opening of the stricture can once be seen, a fine-pointed bougie can often be guided into it without difficulty.

A stricture should never be condemned as impermeable so long as a drop of urine comes out from the meatus; by trying one kind of bougie after another, by carefully and systematically exploring the face of the obstruction, the orifice can be found in nearly every case. Cocaine is of great value: a few drops of a 10 per cent. solution injected into the urethra render it insensitive, and do away to a great extent with the muscular spasm; but, of course, care must be taken not to injure the mucous membrane. An anæsthetic is rarely necessary. Sometimes a drachm of oil may be injected into the urethra with benefit; occasionally the little granulation or fold of mucous membrane which often covers in the orifice and prevents the bougie entering can be floated off in this way; and in some instances, where nothing else succeeds, a bougie can be passed during the act of micturition.

False passages give most trouble: they nearly always start from the floor of the urethra, and, though they are most common in the region of the bulb, they may occur in any part. As a rule a slight check is felt at the moment the point of the instrument slips to one side, and if this is carefully noted it may be avoided afterwards. The patient very often feels it as well, and sometimes is able to give valuable information. When there are several, or when flexible bougies persist in following the wrong track, metal instruments may succeed, the point being guided by the finger in the rectum. Sometimes, if the opening in the mucous membrane is occupied by one instrument, a second may be passed by the side of it in the right direction, but when two or three of these passages start immediately in front of a stricture, the difficulty of avoiding them all is very great.

If there has been great difficulty in introducing a bougie, it may be tied in for a time, beginning with continuous dilatation. When this is not necessary, the bougie is withdrawn, being left only so long as the spasm continues, and a larger one is passed at once before the track is lost. Two or three sizes may be passed in this way every second or third day with the minimum of inconvenience; the best time is in the morning, an hour before the patient is allowed to get up. When the stricture admits No. 8 or 9 English (15 to 17mm. F.), the intervals may be prolonged, but the dilatation should be continued until no obstruction can be felt with a full-sized bullet-sound. Even after this a catheter must be passed occasionally—once a week at first, then once a month, and after a time perhaps at longer periods still, to ensure that there is no recontraction. Unless the stricture is a very recent one, so that the greater part of the infiltration is still cellular, permanent cure is not to be expected.

The dilatation can be effected much more quickly by the use of conical or bellied sounds. The best are Lister's, made of plated steel, so as to combine weight with perfect smoothness of surface. The ends are enlarged a little; behind the neck they increase gradually in thickness until, at the other end of the curve, they are about three sizes (English) larger than the point. With these the strictured tissue may be rapidly stretched to almost any size, and without tearing the mucous membrane. Many patients, however, resent the tension they cause, and there is the disadvantage that the point of the sound is no longer the only part of the instrument that touches the mucous membrane and conveys sensations to the hand of the operator.

(*b*) *Continuous dilatation.*—In this, as already mentioned, the instrument is left lying in the stricture for twenty-four or forty-eight hours, the patient being confined to bed, or, in exceptional cases, allowed to move about a little in his room. A longer time than this without changing the instrument is not advisable; and, owing to the irritation that is set up, it is usually as well to allow an interval of two or three days before the next is introduced. Even then there is usually a mucopurulent discharge from the urethra.

The instrument should never be so large as to fill the stricture; a small one acts just as well as a large one, and is much less likely to cause nervous symptoms; and it should be tied in so that the point lies just in front of the neck of the bladder. Either a bougie or a catheter may be used; if the former, the urine comes by the side; if the latter, the instrument may be pushed into the bladder every now and then, and withdrawn again. In this way a stricture, through which No. 1 English can scarcely pass, will admit a No. 5 and even a No. 6 easily, after forty-eight hours. The presence of the foreign body sets up a certain degree of hyperæmia; the fibrous tissues become soft and swollen; all the meshes are filled with fluid, and the denseness of the cicatrix disappears for a time. Unhappily, if left to itself, without instruments being passed at frequent intervals, contraction sets in even sooner than when the stricture is treated in the intermittent manner.

Merits of dilatation.—This method is most useful in recent strictures, in which the effusion of lymph is still more or less cellular, and has not yet spread beyond the mucous and submucous layers, or involved the periurethral tissues. Those near the meatus, and those in which a band of lymph passes across from wall to wall, can be treated much more satisfactorily in other ways. Dense old cartilaginous strictures frequently will not dilate at all, the tissues are too hard; or, if they do, it is only up to a certain point, No. 5 or 6 (English); then they stop and seem to be entirely unaffected by anything further. Sometimes, too, strictures recontract so rapidly that ncision offers a better prospect; and, occasionally, instances are met with n which patients resent the passage of an instrument to such an extent, hat it is advisable to get rid of the stricture at all hazards by one operation. t is not uncommon to find that though, so long as a stricture persists, every attempt at passing a catheter is followed by a rigor, almost anything may be done, and with impunity, as soon as the constriction is divided.

Continuous dilatation may be employed where there is a very small stricture and great difficulty in finding the orifice, but it is distinctly more liable to be followed by suppression of urine, acute nephritis, and other serious consequences, and relapses are more rapid. Further, it practically necessitates confinement to bed, but in many cases it is almost essential as a first step towards something else.

2. *Rupture.*—Many instruments have been devised for rapidly stretching or tearing through stricture tissue without dividing the mucous membrane. Thompson's is composed of two blades which are passed into the urethra closed, and then very slowly separated to any required extent by means of a lever worked from the handle of the instrument. Holt's is shaped like a catheter divided into parallel halves except at the tip: between these there is a fine central guiding rod (fig. 451). Dilatation is effected by passing on this tubes of various size, so that, when they are forced down between the blades, these are driven asunder. In Berkeley Hill's a wedge on the end of a slender shaft is used instead, so that there is much less friction and the dilatation is limited to one part at a time.

The tissue of which a stricture is formed is quite inelastic; and it is claimed that by the use of these instruments it is either stretched to its utmost, or actually ruptured, without the mucous membrane being torn, though of course it is badly bruised. The process is exceedingly simple, but as a matter of fact the mucous membrane is always torn or crushed, and there is no guarantee that the force is applied to the right place: the weakest part, wherever it is, gives way first. Moreover, this method is peculiarly liable to be followed by the more severe forms of constitutional disturbance—rigors, urethral fever, and suppression of urine; and relapses occur more quickly than they do after gradual dilatation. Even when it is essential for some reason that the stricture should be dilated at once, some form of urethrotomy, where what is done can be felt and regulated at the time, is to be preferred.

3. *Urethrotomy.*—(*a*) *Internal*, incising the stricture from the urethra. This may be done in two ways, either from in front, cutting backwards towards the bladder, or from behind. In either case something must be passed through the stricture first: in the former to act as a guide for the blade of the urethrotome; in the latter to dilate the narrowed part sufficiently to allow the instrument to pass through. Whichever plan is adopted, it is essential that the stricture should be fixed in some way, and that it should be divided through its whole length and depth. Serious hæmorrhage does not occur so long as the incision is limited to the proper structures. The incision is generally made along the floor of the urethra: if Civiale's instrument is used, this is necessary, as the main guide as to the depth of the cut is the sensation conveyed to the finger placed on the skin over the stricture: with the others it is not essential, and the incision may be made at the sides if required. Owing to the presence of large veins, the roof of the urethra is better avoided, so far at least as the penile part of the urethra is concerned.

Division from behind is scarcely possible unless the stricture will admit a No. 5 English, or at least a No. 4; so that if this plan is followed it must in a large number of cases be preceded by dilatation. There are two methods in which it may be accomplished. In Civiale's instrument the end of the shaft is dilated into a bulb, concealing a fine cutting blade; by means of a screw in the handle this can be protruded to the extent required (fig. 452). The bulb is passed through the stricture with the blade sheathed: the penis is drawn up as far as possible so as to fix the part that is to be divided, and the screw turned. The forefinger of the other hand is pressed firmly on the skin over the stricture, and the knife is drawn through, cutting deeper and deeper, until all the tough fibrous bands which grate like so much tendon against the edge are thoroughly divided. Then the knife is sheathed again and the instrument withdrawn. In Otis's, on the other hand, the stricture is fixed and stretched until it is quite tight by gradually separating the two parallel rods; then the knife is protruded as far as is thought advisable and drawn quickly across the tightened bands (fig. 453). If the division is not complete the side rods are screwed apart again and a fresh incision made.

In the anterior part of the urethra these succeed equally well; the one because the strictured part can be held firmly with the fingers, and every fibre felt as it is divided; the other because the touch of the instrument is so light when it is but a short way down the canal. In the deeper part, especially near the bulb, Civiale's is the most convenient.

A stricture that is too small to admit these may be divided from in front by means of Maisonneuve's urethrotome, as modified by Teevan and Berkeley Hill (fig. 454). A filiform bougie must first be passed, and on this an exceedingly fine catheter, so as to make sure that the end is really in the bladder, not coiled up in some false passage. The catheter may then be withdrawn and the guide that screws on to the end of the urethrotome passed instead. The instrument itself consists of two parallel rods, together only equal to a No. 3 English, joined at the tip, but allowing a wedge on the end of the shaft to slide down between them as far as the curve. The knife is concealed in the wedge, and is not protruded until this has been passed as far as it will go; in this way the wall of the urethra and the stricture are firmly held; and the wedge being pushed forward bit by bit, as the tissue is divided with the knife, the whole length may be cut through without endangering anything else.

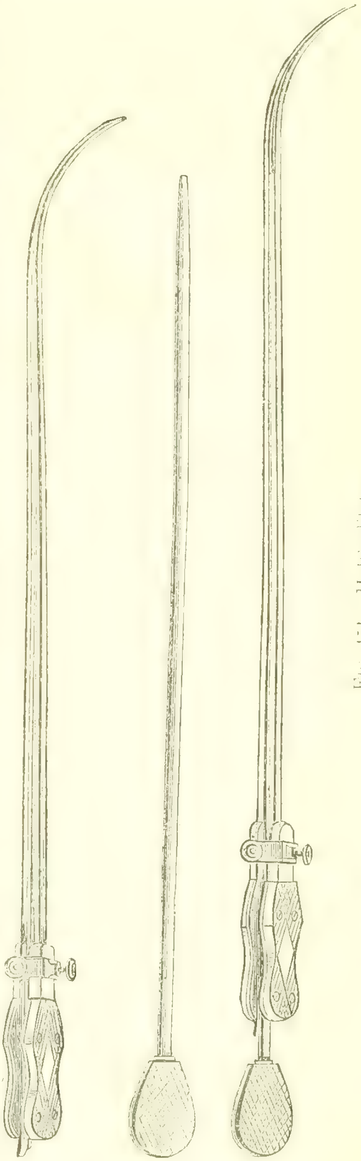

FIG. 451.—Holt's dilator.

The success of this operation depends very greatly upon the after-treatment; if urine becomes infiltrated into the wound, suppuration is sure to occur, leaving behind it a cicatrix which reproduces the stricture in a still worse form; and there is very great danger of other troubles—rigors, urethral fever, abscesses and even pyæmia. A full-sized bullet-sound, No. 14 or 15 English, must be passed to make sure that the stricture is thoroughly divided; the urine that remains in the bladder drawn off; and the cavity washed out with boracic acid or a very dilute solution of corrosive sublimate. No catheter should be tied in unless there is profuse and continuous hæmorrhage. A morphia suppository (if the kidneys are fairly sound) may be placed in the rectum, and then the patient must be removed to bed, and enjoined to delay micturition as long as possible, in order that the surface of the wound may be sealed with lymph before urine is allowed to flow over it. When the bladder must be emptied, which is often not for six or seven hours, a large cup of tea should be given, with five grains of quinine and half an ounce of brandy, and the patient placed in a hot bath, so that the flow of urine may be as free as possible, and without any straining. If this plan is adopted there is rarely any fever after the operation; sometimes a rigor occurs after micturition: within a few minutes the temperature begins to rise, the patient feels chilly and begins to shiver, there is a feeling of the most intense distress; the thermometer reaches 104° F. and even higher; then after twenty minutes or half an hour it begins to fall and profuse sweating sets in; but this is seldom of any import. In any case the patient's temperature should be carefully taken after micturition, and if there is a sensible rise it should be met at once by repeating the quinine. No instrument should be passed for at least a week; the patient must be kept in bed, on light diet and without stimulants; the bowels may be opened on the third day, and a warm bath taken every night. At the end of a week a No. 13 English bullet-sound may be carefully passed down the urethra and withdrawn again; if the operation has been successful, no hitch should be felt anywhere and there should be no stain of blood. Three days later another may be passed, and then the patient may be instructed how to make use of one for himself.

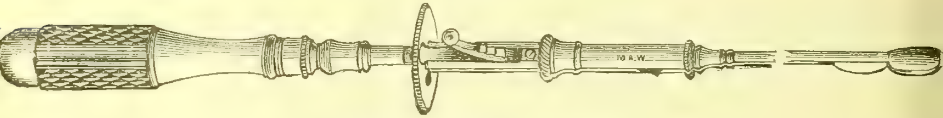

FIG. 452.—Civiale's urethrotome.

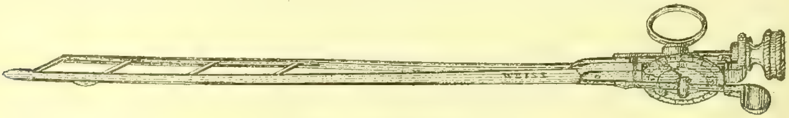

FIG. 453.—Otis's urethrotome.

Internal urethrotomy is employed by some to a very much greater extent than by others, but there are certain cases in which it is generally preferred.

1. Strictures near the meatus, especially those at the orifice itself; these may often be divided with an ordinary bistoury.
2. Strictures which re-contract rapidly after dilatation.
3. Strictures in patients who suffer severely from rigors or other troubles whenever a catheter is passed. In such cases it is best to finish the operation

at a single sitting, and it is often found that the irritability of the urethra disappears altogether as soon as the stricture is divided.

4. If there is a perinæal abscess present, and the stricture is divided before the mucous membrane has given way, a fistula may sometimes be avoided.

Dense cartilaginous strictures that refuse to dilate may be treated in this way, but they frequently require more than one operation, and for them external urethrotomy is certainly to be preferred.

In recent strictures, or where there is advanced disease of the kidneys, or where the urethra is inflamed, a cutting operation is not advisable. In advanced cases of cystitis, where the urine is ammoniacal and loaded with mucus, the stricture may be divided and an opening made in the perinæum to drain the bladder and to prevent decomposing urine flowing over the surface of the wound.

Complications.—Internal urethrotomy is liable to be followed by the same complications as simple catheterism, but some are more common and more serious than others. Rigors have been already mentioned. Hæmorrhage (either at the time of the operation or later, especially at night, if there is an erection) is sometimes very profuse. In the penile part it may be controlled by passing a large gum-elastic catheter down the urethra, and compressing the bleeding point against it with a bandage, until a coagulum has formed; or an ice-bag may be laid upon it; when it is at the bulb a well-padded firm crutch after Otis's plan answers best.

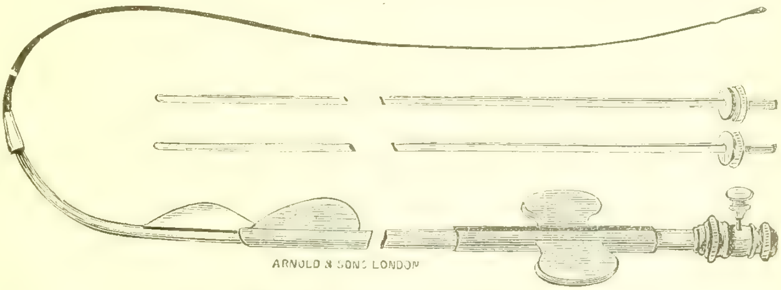

FIG. 454.—Teevan's urethrotome.

If there is evidence of infiltration of urine at the seat of operation, a staff should be passed down the urethra and a free incision made from the outside. Abscesses should be opened as soon as possible; but if they occur in connection with the prostate they usually make their way into the urethra. Acute epididymitis is not uncommon, especially if the urethra is explored too soon and too much after the operation; and, particularly if the kidneys are diseased, partial or complete suppression of urine may occur, though the liability to this occurrence may be greatly lessened by taking proper precautions.

Subcutaneous urethrotomy.—In the penile portion of the urethra short strictures may be divided from the outside by means of a long narrow tenotomy knife. A staff is passed down the urethra, the stricture fixed with the fingers, and the knife thrust through the skin, making a minute puncture, and carried along the staff until all the resisting portion of the stricture has been divided. It is then withdrawn, and the puncture sealed. The after-treatment should be the same is in internal urethrotomy.

(*b*) *External urethrotomy*, where an incision is made from the outside into the urethra, passing through the whole of the stricture tissue.

There are two distinct classes of cases in which this may be required. In the first a catheter can be passed through the stricture; in the second it cannot, either because the urethra has been destroyed by extensive sloughing, or because it is so tortuous that, though urine can find its way out, it is impossible to worm a bougie through it.

Syme's operation, external urethrotomy in the strict sense of the term, where an instrument can be passed into the bladder. Syme's staff consists of two parts of different diameters; for the last two inches and a-half, it is about the size of No. 2 English, and this is grooved on the convexity; the rest of the instrument is equal to a No. 10 or 11 E. The junction of the two is abrupt, so that there is a sharply marked shoulder, which is intended to rest upon the face of the stricture; the groove is continued on to this, but no farther. This is passed into the bladder, the finger being placed in the rectum, to make sure that it has not entered a false passage, and given to an assistant to hold. The patient is then tied up in the lithotomy position, and the assistant directed to push the convexity of the staff downwards towards the perinæum. The left forefinger is placed in the rectum, and an incision made exactly in the middle line, about an inch in front of the anus, and carefully carried down until the groove in the narrow portion of the staff is reached: this is usually behind the stricture. The knife is carried forwards, cutting from the anus, in the groove of the staff, right through the stricture as far as the shoulder. A probe-pointed narrow gorget is introduced through the wound into the groove, and pushed on until it enters the bladder; the staff is withdrawn, and a full-sized catheter passed from the urethra along the gorget, using it as a director. Generally the catheter is tied in for the next three days, and then withdrawn; but I have not found this necessary. If the stricture is divided thoroughly, the wound may be left entirely to itself, the patient being kept in bed, and treated in the same way as after the operation of internal urethrotomy. At the end of a week a full-sized bullet-sound may be passed, following the roof of the urethra, a few drops of a ten per cent. solution of cocaine being injected into the wound to prevent pain; and this may be repeated, at first every second day, and then gradually at longer and longer intervals.

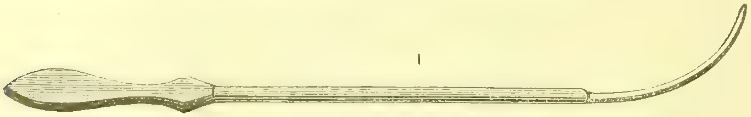

FIG. 455.—Syme's staff.

This operation is especially useful in dense cartilaginous strictures complicated with fistulæ, where internal urethrotomy has no chance of succeeding; and it may be performed with very great benefit in advanced stricture deep in the urethra, where the bladder is diseased, the urine ammoniacal, and the kidneys affected. In this case, however, a drainage-tube should be passed through the wound into the bladder, and connected with a receiver outside the bed. Of course the prognosis in such cases is not good, but it relieves the bladder at once, the urine gradually becomes clear and acid, the amount of mucus diminishes, the constant desire to micturate ceases, the patient enjoys such rest as he has not had for years, and very often the general health begins to improve at once.

There is another advantage claimed for this operation: that it holds out a prospect of permanent cure. There is no doubt that sometimes, if external urethrotomy is performed in cases of rupture of the urethra before extravasation of urine has taken place, the formation of a stricture can be prevented; but Harrison has described cases in which a dense cartilaginous stricture has apparently completely disappeared. In 1867 Bickersteth performed Syme's operation for traumatic stricture and urinary fistulæ of the worst type; in 1869 the man was known to be quite well, though no precautions appear to have been taken by the patient. After his death in 1885 the urethra was removed and carefully examined, and no signs of the stricture could be found; in fact, the urethra is described as being of larger calibre in proportion to the rest of the canal, opposite the line of section, as if the cicatrix had yielded to the pressure of the urine. I have myself the notes of a patient on whom external urethrotomy was performed eighteen years before he came under my care, and though he assures me that he has not taken the slightest precaution since, there is no evidence of any recontraction.

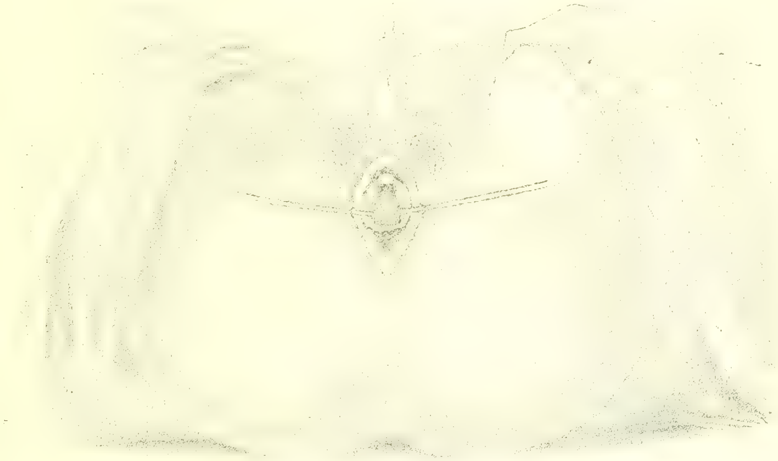

Fig. 456.—Wheelhouse's operation, showing the sides of the urethra held apart by temporary sutures, and the apex of the triangle stretched up by the button on the end of the staff.

When a catheter cannot be introduced into the bladder, either the urethra is laid open in front of the stricture, so that the face of it may be seen (Wheelhouse's operation); or an incision is made into the urethra behind, through the perinæum, and prolonged forwards through the stricture tissue until the canal is reached again in front (Guthrie's perinæal section, or Cock's operation).

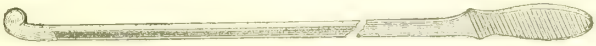

Fig. 457.—Grooved staff, with button-like end.

Wheelhouse's operation.—The patient is placed in the lithotomy position and a special staff passed down as far as the stricture. This instrument is straight, with on one side a groove, which runs down until within half an inch of the point, and on the other, at the point itself, a projection in the form of a blunt hook. An incision is made on to the staff so as to open the urethra a quarter of an inch in front of the stricture, and two sutures are looped through the edges of the mucous membrane so that the sides can be held apart by assistants. The staff is withdrawn until the end appears in the wound, and turned round so that the projection is hooked into the upper angle of the opening in the urethra. This is stretched in this way into the shape of a triangle, the base of which is formed by the front of the stricture. There is very little hæmorrhage, and nearly always the orifice can be seen at once. A probe is then carefully passed through the stricture, and the whole length is carefully and deliberately divided along its under surface. The subsequent proceedings and the after-treatment are the same as in Syme's operation, a probe-pointed narrow gorget being used to pass into the bladder through the wound and act as a guide for the catheter.

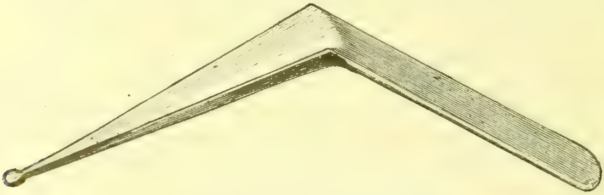

FIG. 458.—Teale's probe-gorget.

Perinæal section.—The patient is directed to hold his urine if possible for some hours before the operation, so that the neck of the bladder and the proximal part of the urethra may be distended. The position is the same, and the surgeon begins by passing his left forefinger into the rectum, to draw it back, and to feel the apex of the prostate. An incision is then made exactly in the middle line of the perinæum an inch and a half in length, and half an inch in front of the anus; and it is gradually deepened, until, if the patient strain or cough, the urethra bulges into the wound. If this does not happen, the point of the knife, guided by the finger in the rectum, must be pushed forwards so as to hit off the membranous portion of the urethra or the apex of the prostate. If urine escapes through the puncture, difficulty is at an end. A director is then passed into the bladder, and along this a narrow probe-pointed gorget. The stricture may either be dealt with at once (the other end is easily found by passing an instrument down the urethra) or the bladder may simply be allowed to drain itself for some days. It is not uncommon to find that a stricture which obstinately resisted all attempts before the operation can be easily passed afterwards and either dilated or divided.

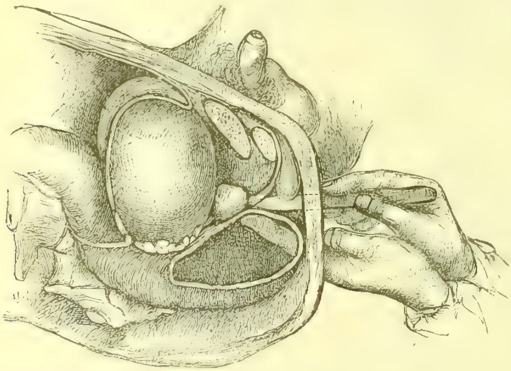

FIG. 459.—Cock's operation of tapping the urethra at the apex of the prostate, or perinæal section.

In cases in which a large portion of the urethra has been destroyed by sloughing, and it is doubtful whether it is possible to establish a new canal or whether if it is established the patient will take the trouble to maintain its patency, an opening may be made into the bladder over the pubes, and fitted with an india-rubber tube and stopcock. With this arrangement patients may live and continue their ordinary occupation, not only with perfect safety, but almost without inconvenience.

4. *Excision.*—In exceptional cases strictures in the penile portion of the urethra have been excised, and the edges of the mucous membrane sutured together; and even strips of mucous membrane from other parts of the body have been spliced in. Such operations, however, can very rarely be required, as most strictures so placed are amenable to simpler treatment.

5. *Electrolysis.*—The treatment of stricture by electrolysis has recently been revived by Newman, Bruce-Clarke, Steavenson, and others. The negative electrode is passed down the urethra, and allowed to remain in contact with the face of the stricture for the space of some minutes to half an hour; the positive is applied to some other part of the patient's body, and a current of three to five milli-ampères used. In stricture near the meatus the gradual melting away of the cicatricial tissue, under the influence of the caustic set free on the surface of the electrode, can be seen, and there is no doubt the same process takes place when the stricture is deeper; but in many patients it is attended with quite as much pain as gradual dilatation. There is usually a considerable degree of soreness and irritation afterwards, and, unless the same precautions are taken, there is no greater degree of immunity. It is true that in some instances recontraction does not occur for a considerable time; but in picked cases the same may be said of nearly every other method; and I have known it take place within six months.

EXTRAVASATION OF URINE

Urine may escape from the ureter and pelvis of the kidney, from the bladder (entering the peritoneal cavity or the cellular tissue), or from the urethra. The last mentioned is by far the most common, and is generally understood by the term extravasation.

Causes.—The urine may come from the prostatic, membranous, or penile portions of the urethra. In the first case the causes (and the symptoms) are practically the same as those of extra-peritoneal rent of the bladder. It rarely occurs except as a result of fracture of the pelvis, or of operations, such as lateral lithotomy when the lobe of the prostate has been too freely incised. In children, however, it sometimes happens from severe compression without fracture, owing to the elasticity of the bones of the pelvis. The urine escapes into the prevesical space (that which is bounded by the two lamellæ of the transversalis fascia, the one going to the pubes, the other along the urachus to the bladder), above the deep layer of the triangular ligament, or else directly into the pelvic cellular tissue, above the rectovesical fascia.

Extravasation from the membranous or penile portion of the urethra is caused either by injury (rupture, impacted calculus, urethrotomy, &c.), or by stricture. The latter is by far the more common. It may be either sudden or gradual. In the former case the urethra becomes thinned and dilated behind the stricture, owing to the constant pressure upon it, until, some day, under the effort of micturition it suddenly gives way, and the urine pours out into the tissues. In the latter a small follicular abscess forms, and gradually extends, ulcerating through everything under the constant pressure of the septic and decomposing urine, until at length it works its way to the exterior, and the urine escapes through a fistula without having been widely spread in the cellular tissue. This is not nearly so severe a form as the other, at any rate so far as the immediate symptoms are concerned.

When the extravasation commences between the two layers of the triangular ligament, it naturally remains limited until one of them, usually the anterior gives way. If, on the other hand, it is superficial to this, under the deep layers of the superficial fascia, it spreads at once until it may actually reach the ensiform cartilage. Behind its progress is limited by the attachment of the fascia to the posterior margin of the triangular ligament; in the middle line it cannot extend farther back than the centrum tendineum of the perinæum; under cover of the rami of the ischium, it can reach as far as the tuberosity, but it never enters the ischiorectal fossa. At the sides the fascia joins the periosteum, so that the urine cannot extend on to the thighs. Only in front is the passage free, and if it is driven with any force it rushes into the scrotum under the dartos, passes over the pubes, and covers the surface of the abdomen, as low as Poupart's ligament at the sides, and perhaps as high as the ensiform cartilage in the middle.

Consequences.—Wherever urine spreads it causes inflammation and gangrene. The cellular tissue sloughs wherever it comes; the skin perishes, and exposes intensely fœtid masses of dark-coloured tissue, sodden with urine and pus; and even the penis, testes, and other structures may be destroyed when the planes of fascia, which serve at first to limit the urine in certain directions, break down.

Symptoms.—Sudden extravasation of urine is unmistakable. There is a history of obstruction, of some difficulty in emptying the bladder, for weeks or months before, if due to stricture—for the first time if the urethra has been ruptured; then, of the obstruction having suddenly given way, and of the bladder having emptied itself with a feeling of intense relief, but without any urine being passed externally. In a few minutes, a smarting sensation is felt in the perinæum and scrotum; soon they begin to burn and throb; in a few hours they swell to more than double the size; the patient becomes anxious and feverish, and a condition of extreme prostration sets in.

By the next day, especially if the urine was already septic, the sloughing is well advanced. The perinæum projects under the scrotum, reddened, tense, and hard; the scrotum itself is swollen out to an enormous size, and is glazed and shining, with a peculiar translucent appearance from the amount of œdema; and the skin over the abdomen is dusky, pitting on pressure, and in bad cases crackling from incipient putrefaction. If there is a gangrenous spot on the penis, the prognosis, as Brodie first showed, is almost hopeless. The fever may be high, but more frequently the temperature is only moderately raised; the patient lies in a state resembling typhoid; the pulse is small and quick, the respiration hurried and shallow, the tongue dry and brown; often there is muttering delirium; and the eyes are sunken, and the face pinched, with a look upon it that cannot be mistaken.

Treatment.—This admits of no delay: the patient must at once be placed in the lithotomy position, and a free incision made deep in the middle line of the perinæum, until the main source is tapped. Then other incisions must be made all over the dusky area; in the penis they must be perfectly straight and longitudinal, or the subsequent cicatrisation may lead to serious trouble ; on the scrotum one on each side is usually sufficient, but it should extend thoroughly into the sodden cellular tissue ; over the abdomen their direction should correspond with the vessels. In most cases it is sufficient to make them two or three inches long ; as soon as the œdema subsides they shrink more than half ; sometimes there is sharp hæmorrhage from a cutaneous vessel, but this may always be stopped by pressure with dried lint. Any sloughs that are loose should be extracted at once, and as much of the putrid fluid as possible squeezed out of the openings.

The treatment of the bladder, and of the stricture (if there is one), next requires consideration. It is distinctly of advantage to drain the former thoroughly, not only because it prevents more urine being extravasated, but because itself it is almost sure to be in a state of advanced cystitis, half full of an intensely offensive putrid fluid. This may be accomplished either by dilating the prostatic portion of the urethra with the finger, first introducing a probe-pointed gorget into the bladder as a guide, or, better, by passing in a full-sized soft rubber catheter, and connecting it with a receptacle under the bed. Whether the stricture should be touched or not depends upon the condition of the patient. In most instances it is better to leave it alone ; if the patient recovers, a catheter can often be passed without any difficulty ; owing to the prolonged rest, the spasm and congestion entirely disappear. When, however, the case is not a severe one, it is more expeditious to pass a staff down the urethra, and at once lay the whole stricture open, as in external urethrotomy.

Great care must be taken to keep the patient dry : all the discharges (and they are often profuse), must be soaked up with frequently changed pads of absorbent wool, or finely picked oakum. Warm hip-baths, containing small quantities of some antiseptic, are of great service, if the patient's health permits. Sloughs should be removed as soon as possible, and the strength sustained by nourishing diet, quinine, and stimulants. The temperature requires very careful watching, as, like all operations about the urinary organs, extravasation is liable to be followed by pyæmia. If the patient does not die from this, exhaustion, or renal disease, the wounds granulate in a very short time, and the cicatrices left are always surprisingly small.

Urinary Abscess

Peri-urethral abscesses are not uncommon in the glans by the side of the frænum in acute gonorrhœa, and occasionally they are met with in other parts of the corpus spongiosum, but the perinæum is by far the favourite locality. They may be divided into two classes, those which communicate with the urethra from the first, having commenced on the surface of the mucous membrane, and gradually involved deeper and deeper structures ; and those which originate independently of it, and if they do communicate only do so secondarily, the mucous membrane covering them becoming thinner and thinner until at last it gives way.

Causes. 1. *Gonorrhœa.*—Abscesses occasionally form in the corpus spongiosum, but (except in the glans) they are not often met with unless there is an old stricture, or unless it has been necessary to pass a catheter frequently. Sometimes they extend down from the mucous follicles ; but they may originate independently, and if the pus is let out in time they may never communicate with the urethra at all.

Cowper's glands are sometimes affected in this way. There is a small, hard, exceedingly tender spot, not quite in the middle line, by the root of the scrotum. After a time it works its way through the triangular ligament, towards the skin, or towards the rectum, so that its origin is often not recognised.

2. *Injury.*—Rupture of the urethra, impacted calculus, the formation of a false passage, internal urethrotomy, and forcible splitting of strictures, are occasionally followed by perinæal abscesses. Some of these are due to infiltration of urine; but when, for example, a stricture is ruptured without the mucous membrane being torn, or when suppuration occurs in consequence of a catheter having been tied into the urethra, it is probable that the communication, if it exists, is secondary.

3. *Stricture.*—This is by far the most common.

Usually the suppuration commences outside the urethra, in the thickness of the stricture tissue; sometimes, however, it spreads from the interior—the mucous membrane is thinned and driven into pouches, which often contain small quantities of decomposing urine; ulceration spreads from these into the mass of inflammatory exudation around, and the communication exists from the first.

Abscesses may, of course, occur in the perinæum from other causes, the urethra not being concerned in any way. Suppuration, for example, may occur in connection with the rectum, and work its way outwards in front of the anus; and periprostatic abscesses sometimes point in the same situation.

Symptoms.—Urinary abscess, except when it is the result of gonorrhœa, is usually of slow formation. If it occurs in the glans, there is a small hard mass on one or both sides of the frænum, exceedingly tender to the touch, and rapidly coming to the surface. In the perinæum it depends to a certain extent upon the situation. Usually it is in the middle line, unless it originates in inflammation of Cowper's glands; if it is in connection with the bulb, or the deeper part of the corpus spongiosum, it stands out to a certain extent from the fixed tissues beneath, and often runs forwards with a hard spur-like process in the median raphé of the scrotum. When it begins between the layers of the triangular ligament, there is merely a hard, but exceedingly tender spot, scarcely raised above the level of the rest. Fluctuation cannot be felt unless the abscess is superficial.

The pain at the first is dull and throbbing, with a great sense of weight; the stream of urine (even when there is no stricture), is reduced in size and force; complete retention may occur, especially when the suppuration is in connection with the fixed portion of the urethra; and sitting and walking are attended with great discomfort. Then, as the pus forms, the pain becomes more intense, and shoots down the thighs and into the groin; very often there is high fever, with perhaps a rigor; and constitutional symptoms of great severity may set in. If the abscess is allowed to break of itself, it may discharge into the urethra; there is a sense of intense relief; a certain amount of pus is washed down with the urine, and sometimes the cavity contracts and heals without any extravasation, and without an external opening. More often, especially if there is a stricture, the abscess bursts externally as well as internally, and though the channel contracts as soon as the tension is removed, urine escapes through the opening, and a fistula is formed.

Treatment.—Urinary abscess should be opened in all cases as soon as possible. It is no use waiting for fluctuation, the sheets of fasciæ are so dense that the pus, if left to itself, often burrows long distances before it reaches the surface ; and if there is no internal opening, a timely external one may prevent its occurrence. Buckston-Browne has pointed out that in cases of stricture associated with perinæal abscess, if internal urethrotomy is performed, and the abscess opened freely from the outside, a fistula may often be prevented. Care must be taken that the incision, if the abscess is in the perinæum, is kept absolutely to the middle line.

URINARY FISTULA

Fistulæ may occur in connection with the kidney, ureter, or bladder, after wounds or operations, and as a result of malignant disease. Sometimes they open directly on to the exterior ; sometimes they communicate with other organs—the rectum, vagina, or even the small intestine. Recent ones, in which there has been no great loss of tissue, and which are not kept open by a permanent irritant, generally close of themselves if the natural channel is patent. Attention to drainage and position (the patient, for example, lying prone when there is an opening between the bladder and rectum), the free use of antiseptics and astringents, and the occasional application of caustics, such as the actual cautery, or nitrate of silver melted on a probe, are of material assistance. If, however, they are old, and the walls have degenerated into dense suppurating sinuses, the surface of which is very likely coated over with a layer of phosphates ; or if there is any persistent irritant (the capsule, for example, of a scrofulous kidney drained through the loin), further and sometimes extensive operations are required. These, however, and vesico-vaginal fistulæ must be dealt with by themselves.

Urethral fistulæ.—These differ in severity, and may be divided into three classes :

1. Simple straight channels, of recent formation, opening directly on to the exterior, without much induration around.

2. Complicated fistulæ, sometimes very numerous (as many as fifty have been described), opening in all directions, over the penis, in the groin, in the ischiorectal fossa—anywhere near, in fact, with pouches and sinuses in which urine collects and decomposes, and embedded in dense cicatricial tissue.

3. Fistulæ, very often in the penile part, in which, owing to extravasation of urine, phagedæna, or other causes, there has been great loss of tissue.

Urethral fistula, except in those rare cases in which portions of the penis are removed by injury, is always the result of inflammation, and therefore nearly always of stricture. Abscesses, however, leaving sinuses behind them, do occasionally occur from other causes, such as rupture of the urethra, impacted calculus, or urethrotomy. It is not material whether the suppuration commences on the surface of the mucous membrane, in connection with an inflamed follicle or dilated pouch ; or whether it originates independently of this, in the tissues around ; in either case the urine finds its way out through an easier channel, and a fistula is formed. In the majority of instances it affords little or no relief to the stricture. If there is a very wide opening, or if, as in suprapubic puncture of the bladder, the sinus is fitted with a suitable instrument, so that there is free exit for the urine, the bladder, being relieved from all tension, may recover its normal condition—to a certain extent at least—and the ill effects of stricture be avoided; but, except in such cases as these, the orifice of the fistula soon contracts until it is no larger than a pinhole, fresh inflammation takes place around it, more abscesses form, each leaving a new fistula, and at length the whole perinæum is converted into a dense mass of cicatricial tissue, riddled with openings in all directions.

Treatment.—The treatment of urinary fistula depends upon the cause. The first thing is to remove any foreign body that is present (a calculus, for example), and to see that the natural exit for the urine is unimpeded in any way.

If the fistula is recent, and dependent, as it usually is, upon stricture, it will nearly always contract and heal up as soon as the stricture is cured. Sometimes it helps to stimulate the walls by injecting tincture of iodine, or to touch up the deeper part of the sinus with the actual cautery, or with a probe upon which some nitrate of silver has been fused. If, in spite of this, it will not close, means must be taken to prevent any urine passing through. Occasionally it is sufficient to press firmly with the finger upon the external orifice during the act of micturition. More frequently it is necessary to draw the urine off with a soft catheter as often as may be required, so that no drop shall flow along the urethra. This must, of course, be done before each act of defæcation, and if, in spite of these precautions, the least drop escapes the urethra must at once be thoroughly washed out with a weak astringent. It is no use tying a catheter in the bladder (unless it is connected with some constantly acting exhausting apparatus to suck the urine out), some will always pass by the side, no matter what the size may be; and not unfrequently it is positively injurious from the amount of irritation it creates.

If this does not succeed and the stricture is fully dilated, it is possible that the irritation is kept up by some outlying sinus which cannot drain. In such a case it is best to perform external urethrotomy at once, cutting through the whole of the dense tissue in which the fistula lies. If there are many openings, or if there is an old cartilaginous stricture to deal with, this is almost always necessary.

Where a considerable portion of the wall has been destroyed by sloughing, a plastic operation may have to be performed in order to close the opening. To secure union by the first intention, the bladder should be drained, either through the rectum, introducing a winged soft catheter, or through an opening in the perinæum, according to the position of the fistula. Then the edges may be pared and brought together, or a flap of skin may be raised from some adjoining part, and shifted so as to cover in the orifice.

The Female Urethra

The urethra in women is so short, and the extent of surface so small in comparison with that of the male, that it is much less likely to become inflamed, and stricture and other consequences are more rare.

Acute inflammation, commencing with great severity, and attended with scalding and a purulent discharge, is not infrequent as a result of gonorrhœal infection of the vulva. Milder forms are occasionally met with as a consequence of cystitis, and a slight but very troublesome degree of irritation, with increased secretion of mucus, is not uncommon during pregnancy, in malposition of the uterus, and in other affections of the generative organs. As a rule, unless the cause is a persistent one, it subsides readily under the use of astringent injections, combined with hot baths and purgatives. Stricture, as a result of inflammation, is rare; but it may occur from chancres or other sores at the orifice, and from sloughing of part of the anterior wall of the vagina. It may be treated either by dilatation or incision; rigors have been known to occur, as in men, but very seldom.

The opposite condition, dilatation, is occasionally met with, and when it involves the upper third, and still more the whole length, there is the most distressing incontinence. It may result from long-continued or often-repeated displacement, or from mechanical stretching. The adult urethra admits the forefinger easily, and, as a rule, if the dilatation is effected rapidly, no ill result happens; but if it is often repeated, or if it is carried beyond this, as in extracting a calculus, it may become permanent. Sometimes the middle portion only is dilated into a pouch (urethrocele) felt in the anterior wall of the vagina, and this, acting as a receptacle for decomposing urine, keeps up the irritation. When there is incontinence, due to impaired power at the neck of the bladder, galvanism, tonics, strychnia, cold, and other measures must be employed to restore the tone of the muscle.

Urethral caruncle, a small vascular growth at the meatus, occurring more frequently in married women than in young unmarried girls, may give rise to the greatest distress. It bleeds with the least touch, and causes the most intense suffering during micturition or when the parts are moved; at the same time there is usually great irritability of the bladder and a profuse discharge of mucus. The symptoms cease at once on its removal.

Fissure at the neck of the bladder is also occasionally met with, but it can only be diagnosed with the endoscope. There is a small superficial erosion of the mucous membrane, circular when the sphincter is stretched, but appearing like a fissure as soon as it contracts. It gives rise to constant tenesmus and straining, with an intense burning pain at the end of micturition, and occasionally a few drops of blood. It may readily be cured by means of a light application of caustic, or by mechanically dilating the sphincter so as to give the surface rest. The former method is preferable, as it is not always possible to graduate the effects of the latter sufficiently in individual cases.

CHAPTER XXIV

INJURIES AND DISEASES OF THE MALE ORGANS

MALFORMATION AND DISEASES OF THE PENIS

The roof may be defective (epispadias); or the floor (hypospadias); or the invagination that forms the fossa navicularis may fail to meet the part behind if in this case there is no other defect, the urethra is imperforate, the kidneys become cystic, and the child dies at or before birth. Usually, however, there is hypospadias, and occasionally the two channels run one above the other for a considerable distance.

Hypospadias.—The orifice is usually at the base of the glans, or a little farther back; the frænum is wanting; the prepuce forms a great fold on the dorsum like a cowl, and the corpus spongiosum possesses scarcely any erectile tissue. In other cases it lies at the end of the membranous urethra the bulb and the scrotum failing to unite in the middle line, and forming labia, as in the female. When the defect is slight, the fossa navicularis may run back and end blindly; in other cases the penis is small, and the corpus spongiosum (if it is developed) incapable of erection.

Epispadias.—The complete form is always associated with ectopia vesicæ: occasionally the urethra opens behind the corona, the rest of the penis being well developed.

The treatment is not very promising. If the defect is slight, and micturition not impeded, it is better not to interfere. The orifice should be dilated to prevent any strain upon the structures behind; and if the urethra fails in front, so that it is impossible to direct the stream, an attempt should be made to carry it forwards by means of a plastic operation. The flap must be double, so that a cutaneous surface may face the new channel; the deeper layer is taken from the side of the penis near, and twisted round upon itself; the superficial one borrowed from the redundant prepuce, the centre of the cowl being dissected up, and the glans thrust through the opening so that the dorsal surface becomes inferior, or *vice versâ*, as the case may be.

Phimosis may be congenital or acquired, following balanitis, soft sores, chancre or injury. In the former case the glans is often adherent, and the orifice may be reduced to the size of a pinhole, so that the prepuce swells out with each act of micturition. Circumcision should always be performed, unless the corona can be thoroughly and easily exposed: the secretion collects inside; there is a constant risk of balanitis and paraphimosis; preputial calculi may form; and the liability to syphilis and phagedæna is much greater. If gonorrhœa occurs, it is more severe; and the constant irritation undoubtedly favours carcinoma.

Circumcision.—The prepuce is drawn well forward, and clipped with a pair of polypus-forceps in front of the glans; the projecting end cut off; the cutaneous sheath allowed to retract; and the mucous membrane slit up along the dorsum as far as its attachment. Each half is then cut away, following the line of the corona, and leaving the frænum and just enough to hold a few sutures. If catgut is used, and the wound dried and covered with iodoform, the dressing may remain on until the skin has united.

Paraphimosis is the condition produced by forcing the glans through the orifice of the prepuce, when it is too narrow to admit it. The immediate result is congestion and inflammation, ending, if left, in ulceration and sloughing. The glans becomes swollen: the prepuce overhangs it like an œdematous collar, and concealed behind this is a tight unyielding ring formed by the orifice. In early cases reduction can usually be effected by oiling the parts well, and drawing the foreskin forwards with the index and middle fingers of the two hands, while the thumbs compress the glans; or the penis may be wrapped round with lint, and gently squeezed in the hand until the œdema disappears; but in cases that have already lasted some days, it is often necessary to slip the end of a director under the constricting band on the dorsum, and divide it with a bistoury.

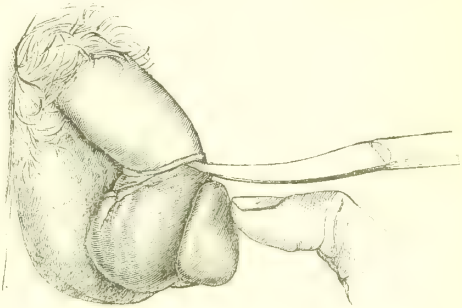

FIG. 460.—Mode of dividing prepuce in paraphimosis.

EPITHELIOMA OF THE PENIS

Squamous epithelioma is not uncommon after middle life, commencing on the glans or the inner surface of the prepuce, especially in cases of phimosis. It usually begins as a warty nodule, which soon breaks down into an ulcer, with intensely hard base and edges. If left, the growth spreads rapidly, owing to the constant irritation of the urine; the corpora cavernosa and the glans are quickly infiltrated; the lymphatics in the groin become involved, and secondary deposits follow. The diagnosis from syphilis rests chiefly on the character of the base, which is covered with decaying epithelium, and the intense induration beneath and around.

Amputation is the only treatment. Until recently this was accomplished either with a single sweep of the knife, or more deliberately, forming a flap of skin to cover the surface of the wound, leaving the corpus spongiosum and the urethra longer than the rest, and stitching the edge of the mucous membrane to that of the skin. Recurrence, however, is exceedingly common after this operation; cicatricial stricture at the orifice invariable; and all power of directing the stream of urine lost. To avoid this, Thiersch recommends an oval incision round the root of the penis, prolonged a little backwards in the median raphé of the scrotum, and then dissecting off the whole of the corpora cavernosa from the rami of the pubes and the triangular ligament. The corpus spongiosum and the urethra are dealt with separately, through an incision in the median line of the perinæum behind, as muc being removed as appears desirable, and the rest sutured to the skin in fro of the anus. Micturition must of course be effected in the sitting postur but there is not the same tendency to the formation of stricture, and ther is much greater freedom from return of the growth.

Wheelhouse has pointed out the greatly increased comfort the patien experiences when the testes are removed as well.

DISEASES OF THE SCROTUM

Œdema may occur in Bright's disease, causing enormous swelling; an a similar affection (probably inflammatory in origin) is occasionally me with in infancy.

Inflammation is very common, but unless the cause is very grave (as i extravasation of urine), or the nutrition much enfeebled, as in specific fever sloughing and gangrene rarely occur. It may arise from injury, eczema, th irritation of the urine, or retained perspiration, or it may start from the interior, or spread from other tissues. The swelling is usually immense, bu the other signs, pain, heat, and redness, are seldom in proportion.

Elephantiasis.—Enormous hypertrophy of the tissues of the scrotu may be caused by lymphatic obstruction, or by repeated attacks of inflammation, as in cases of urinary fistula. The skin and subcutaneous tissues onl are affected, the cellular elements and the fibrous tissue being immensel increased, while all the interstices are filled with lymph, or in rarer case with a mixture of this with chyle. Hydrocele is usually associated with it, and the skin of the penis may become involved, but the testes are neve affected (see p. 313).

Epithelioma is of interest from the fact that its origin can nearly alway be traced to local irritation caused by soot—whence its common name, chimney-sweep's cancer.

It begins as a wart or nodule, which slowly spreads at the margin as i decays and ulcerates in the centre. Induration is its chief feature. The edges are raised, hard, and ill-defined: the base is covered with decaying epidermis and florid granulations which discharge a thin offensive fluid, and the tissues around are swollen and œdematous. At first it can be pinched up from the structures beneath, and merely feels like an induration in the skin; soon it infects the lymphatic glands in the groin, spreads to the rest of the scrotum and the penis, and involves the testicles as well.

Fortunately its character is so well known among those liable to i (soot may cause it in other parts of the body, and there is reason to believe that tar may do the same), and its progress (for epithelioma) is so slow that removal in time is usually possible. Even if the inguinal glands are enlarged and broken down, the whole of the disease may sometimes be successfully scraped out.

EXAMINATION OF SCROTAL SWELLINGS

Swellings of the scrotum are divided into those that occupy the canal as well as the scrotum, and those that are confined to the latter situation. The distinction is made by feeling the cord immediately below the pubes, whether it is the natural size, with all its components distinct, or whether it is thickened or concealed in any way.

1. Swellings that occupy the Canal as well as the Scrotum: of these some are reducible, others are not

(a) *Reducible*

Bubonocele and *scrotal hernia* may be recognised by the way in which they disappear, whether they consist of intestine or omentum.

Varicocele, by its characteristic feel: the way in which it disappears when the patient lies down and the scrotum is raised, and refills in spite of the pressure of the finger on the ring.

Congenital hydrocele by its translucency. As the neck of the canal is often long and narrow, reduction is not always easy.

(b) *Irreducible*

Hernia, either because it is *strangulated* (in which case there is no impulse on coughing), or because it is *irreducible*, i.e., so altered in shape, or so tied down by adhesions, that it cannot pass back. In strangulation, constitutional symptoms are present as well.

Infantile hydrocele.—The neck of the tunica vaginalis is obliterated only at the internal abdominal ring, and a collection of fluid extends from the bottom of the scrotum along the inguinal canal. The slow formation, commencing below and extending upwards, the translucency and the absence of true impulse (if it extends really into the canal there may be a kind of shock transmitted), are distinctive.

Inflammatory affections of the cord.—In urethral epididymitis this is sometimes swollen to a considerable size; in tubercular disease the vas only is thickened, and all the structures of the cord can be isolated.

Growths on the cord.—The most common is *encysted hydrocele*, a small round and tense fluid swelling, due to incomplete obliteration of the funicular portion of the tunica vaginalis. It is movable in the canal, but cannot really be reduced, and it is adherent to the cord, forming part of it and moving with it.

Lipoma, sarcoma, and other growths may occur, but they are very rare. Secondary infiltration is always present in malignant disease of the testis, if the gland is not speedily removed. *Hæmatocele* of the cord has been described.

2. Swellings confined to the Scrotum

(a) *Those connected with the Scrotum itself*

Œdema.—In Bright's disease, the whole scrotum sometimes becomes enormously distended, without the legs being much affected. A moment's consideration is sufficient, but I have known serious mistakes made.

Elephantiasis.—In the tropical variety there can be no hesitation, but occasionally a greatly thickened and hardened condition, not so plainly recognised, is met with as a result of neglected stricture.

Lipoma, epithelioma, and other varieties of new growths may occur.

(*b*) *Those connected with the Testis and its coverings: these may be solid or fluid*

The former include inflammatory diseases and tumours of the testis. The chief difficulty occurs with hæmatocele and old hydrocele, the walls of which may be so thick that they are practically solid.

The latter may be connected with the tunica vaginalis (hydrocele or hæmatocele); the testis or epididymis (encysted hydrocele); or the lower end of the cord (hydrocele of the cord); or they may be independent cysts—dermoid, for example, or hydatid. Some difficulty may arise from what is known as hydrosarcocele, a collection of fluid in the tunica vaginalis, surrounding and concealing an enlargement of the testis; and the diagnosis may remain uncertain until the fluid is drawn off.

Malformations of the Testes

The full development of the testis is not reached until sexual maturity. It may fail: (1) either in its original formation; (2) in its evolution (including its descent into the scrotum); or in both together. In addition, it occasionally happens that, though perfectly developed, it becomes displaced (malposition).

(1) *Defective formation.*—The testis and epididymis are developed independently of each other, although they are in close connection; sometimes one fails, sometimes the other. If the former, the epididymis and the vas may occupy their normal situation, the gland itself being represented only by a nodule; if the latter, the testis may be well developed and of its normal size, although its secretion fails to reach the urethra. Sometimes the whole of the epididymis is wanting; more frequently only part, and the vas terminates blindly. If both testicles are wanting, sexual development at puberty does not take place, and often there is malformation of the other organs.

(2) *Defective evolution.*—The testis may fail to attain the normal size, or its normal position, or both.

(*a*) *Imperfect evolution of the testis when in its normal situation.*—In most instances the cause is unknown: the subject of it, when the affection is bilateral, has an effeminate appearance; the voice does not break; the larynx remains small; there is no growth of hair; and the limbs are smooth and rounded. When it is unilateral, it is often associated with varicocele, but it is more probable that they are both dependent upon the same cause, whatever that may be, than that one is the consequence of the other.

(*b*) *Non-descent.*—Descent of the testis may be delayed, or may fail to take place, wholly or in part. In the former case the testis is usually well developed and the descent is completed at puberty, when the organ becomes sexually mature. In the latter it is usually small and flabby.

The cause is very uncertain, except in those cases in which there is a distinct mechanical impediment, such as fusion of the two glands. Adhesions to neighbouring structures (especially the intestine) are often present, but there is no proof that they are the reason. The gland may remain in its original position, or be arrested in the iliac fossa or in the inguinal canal. The sac of the tunica vaginalis nearly always remains open; hernia is, in consequence, very often present as well, and, if not, is always liable to occur;

and, not unfrequently, owing to slight attacks of inflammation, there are adhesions between the intestine and the gland.

The **symptoms** and **treatment** depend upon its position and mobility.

If it lies in the iliac fossa, it is well out of the way of injury, and nothing is required but a truss to prevent the development of hernia.

If it lies in the inguinal canal and is sufficiently movable to pass out of the external ring, the same treatment may be adopted, a horseshoe-pad being used to avoid undue pressure upon it.

If it is fixed between the muscles the conditions are different. In most cases a truss cannot be worn, and there is constant danger of hernia. The gland itself is always liable to injury and inflammation; if this occurs, satisfactory evolution at puberty is improbable; and, like other ill-developed organs, it is liable to become the seat of malignant disease. Under these circumstances, if the tendency to hernia cannot be prevented, or if there has been an attack of inflammation, the gland is better removed. It is, in all probability, functionally useless, and is a constant source of danger.

In cases of strangulated hernia the treatment of the gland depends upon its condition. If it appears fairly well formed and not too much tied down by adhesions, and if the vas is of sufficient length and the scrotum will admit it, an attempt may be made to transplant it. If this cannot be done it should be excised.

3. *Malposition.*—The testis may be in its normal position, but inverted; the epididymis and the vas deferens lying in front of the other structures. If hydrocele or hæmatocele occurs, and this condition is not recognised, the gland is liable to be punctured instead of the tunica vaginalis.

In other cases the testis passes out through the inguinal canal into the perinæum, or misses this altogether and slips into the crural ring, even passing out on to the thigh. The treatment consists either in transplantation (waiting until the child is two or three years old) or excision, according to the condition of the scrotum and the gland and the amount of inconvenience it is likely to cause.

Neuralgia of the Testis

Pain and retraction of the testis are of frequent occurrence in disease of the kidneys and affections involving branches of the lumbar plexus; further, after obliteration of the vas, sexual intercourse, or even excitement, may be attended with severe pain and swelling of the gland; in addition to this, however, the testes in certain people are liable to attacks of intense neuralgia, coming on at regular intervals or excited by the most trivial irritant. Usually one only is affected, but both may be; the gland may be apparently well nourished, or it may be small and flabby; it may be exceedingly irritable, resenting the slightest touch, or there may be nothing noteworthy about it.

In many cases there is a history of injury, but it seldom stands cross-examination. Gout, malaria, anæmia, and other constitutional ailments are sometimes present. It may occur in the most continent; and though in many there is a history of abuse, it is difficult to connect one condition directly with the other. Sexual hypochondriasis may be associated with it, and often the family history is decidedly neurotic.

Treatment is very unsatisfactory. Any local or constitutional cause that can be detected must of course receive thorough consideration; a suspender must be worn; lead, or some other cooling lotion applied; and the thoughts and ideas as far as possible directed into other channels. Cupping over the loins, massage of the back, and the free (local) use of anodynes may be tried as well. If there is a large varicocele, operation may give relief, but castration is useless.

Atrophy

Rupture or ligature of the spermatic artery and occasionally, acute orchitis (especially that variety which is associated with mumps) are the chief causes, the testicle shrinking to a small nodule. I have known the same thing occur after a blow. Rupture or ligature of the vas deferens; chronic epididymitis; the pressure of ill-fitting trusses; and abuse, may be followed by the same effect, but the wasting is seldom so extreme. Whether it is ever a result of varicocele is doubtful, though this is often associated with a soft and flabby condition of the gland.

The opposite result, hypertrophy, is said to occur as compensation in cases of unilateral retention.

ORCHITIS AND EPIDIDYMITIS

Inflammation of the testis may be caused by injury, morbid conditions of the blood, as in gout or rheumatism, extension from neighbouring structures, or the presence of specific irritants, such as those of tubercle and syphilis. It may affect the testis, only or chiefly (orchitis); or the epididymis (epididymitis); and it may be acute or chronic, ending in resolution, organisation, caseation, or suppuration, according to the cause. In addition, acute orchitis is sometimes due to 'metastasis' in connection with mumps, but only after puberty, and not apparently with equal frequency in all epidemics.

1. Acute Inflammation

(*a*) *Acute orchitis* may be caused by metastasis (the parotid is occasionally not affected), injury or pyæmia; or it may be due to extension from the epididymis or tunica vaginalis. Sub-acute attacks are not uncommon in gout and syphilis.

The gland is swollen and exquisitely tender, but owing to the toughness of the tunica albuginea it retains its shape, and is not so large as in epididymitis, or flattened on the side. The skin is red and œdematous; the temperature raised, the veins swollen, and the cord thickened and tender, but the structures composing it are not matted together, and the vas is but little affected. The tunica vaginalis is filled with fluid (acute hydrocele) and sometimes obscures the local signs altogether—there is merely evidence of intense inflammation without its being possible to say from the appearance of the swelling whether it is confined to the tunica vaginalis or involves the testis inside. Pain is always severe and of a peculiarly sickening character, with heavy dragging in the loins; and the constitutional symptoms are often very grave, delirium sometimes occurring in the metastatic variety.

Localised peritonitis with spasmodic contraction of the abdominal muscles is not unfrequent when a retained testis is inflamed, and it has been known to prove fatal.

(*b*) *Acute epididymitis* is nearly always due to extension from the urethra, though the actual outbreak is often determined by local injury. It may be caused by any irritation affecting the prostatic portion, gonorrhœa (not the acute stage, but later when the gleet is chronic), impacted calculus, injections, lithotrity, or even the passage of a catheter. Exceptionally it follows injury alone, or occurs in the course of pyæmia. Sub-acute varieties are met with in the early stage of secondary syphilis, and occasionally as a result of stricture and chronic urethritis. This is of special importance, as sometimes, when there has been no acute attack, the enlargement closely resembles that due to tubercle before caseation has begun.

The general symptoms are the same as those of acute orchitis, but the two affections can nearly always be distinguished. The shape is different: instead of being rounded, it is flattened by the pressure of the thigh upon the outer side; and the testis can be felt, soft and almost painless in the front. The skin is red and œdematous, especially behind and below, and it cannot be pinched up into a fold or lifted off the subjacent structures. The pain begins in the loins before there is local tenderness, and in the same way the groin may be exquisitely sensitive before the testis is affected. But the most important point of all is the condition of the cord: the vas deferens is enlarged; the cord immensely thickened; and all the structures in it matted together so that they cannot be isolated. Epididymitis is rather more common upon the left side than the right, and seldom involves both at the same time, though the second is frequently attacked as the first is getting well.

The urethral discharge ceases so long as the inflammation is acute, and begins again as it subsides.

Termination.—Acute inflammation, whether it involves the testis or the epididymis, or both (for it not unfrequently extends from one to the other), usually ends in resolution, but not always. Partial organisation may occur, affecting especially the exudation in and around the globus minor. An indurated mass is left, painless, gradually sinking into a small hard nodule, apparently insignificant, but often leading to obstruction or stricture of the vas. If it occurs on both sides and does not undergo speedy resolution the subject is sterile. Atrophy may occur, and in the case of orchitis be complete. Epididymitis, even when the vas is obstructed, seldom leads to this; sexual intercourse may be very painful and be followed by the swelling of the gland, but unless the artery is obliterated at the same time the testis seldom wastes altogether. A curiously irritable condition sometimes persists, the testis and even the skin of the scrotum remaining exquisitely tender. Suppuration occasionally follows: gangrene of the scrotum and sloughing of the testis have been known; and tubercular disease is not uncommon. Whether epididymitis has any connection with the vaginal hydrocele that so frequently develops in later life is uncertain. The acute effusion that accompanies the attack subsides with it, though it may leave permanent adhesions, and sometimes causes obliteration.

Treatment.—If possible the patient should be confined to bed with the scrotum raised on a small pillow between the thighs. In other cases a suspender must be used, but the effect is not nearly so good. The bowels should be freely opened, liquid diet only allowed, and rest ensured by means of morphia or chloral. In young plethoric patients with a hard, bounding pulse full doses of antimony may be given at frequent intervals until there is a distinct feeling of nausea, but this is of no good after the first twenty-four hours, and only when the fever begins with severity. Smaller doses three times a day are useful later, if the skin continues hot and dry, or the headache is severe.

In urethral epididymitis cold is by far the best application, especially at the beginning. An ice-bag may be laid upon the part, or Leiter's coils used, lead lotion being substituted after twenty-four hours. If the patient cannot remain in bed, the skin of the scrotum should be covered over with extract of belladonna and glycerine; and then, the other testis being pushed out of the way, surrounded with many layers of cotton-wool and subjected to gentle compression by means of a laced-up bag suspender. A few common rubber bands may be placed outside this with advantage. The application should be renewed at least twice a day, the patient fomenting the part each time with hot water, or, better, sitting in a hot bath. If the belladonna causes any irritation, lead may be substituted for it. The urethra should, of course, be left alone, not only during the inflammation, but after it has subsided.

If the effusion into the tunica vaginalis is at all considerable, a few punctures may be made with a fine tenotomy knife, or an ordinary trocar and cannula may be introduced; and if the veins of the scrotum are distended, they may be pricked and encouraged to bleed; or leeches may be placed upon the inguinal canal; but, although it is largely practised by some surgeons, and apparently with impunity, puncture of the testis itself is not advisable.

Later, when the acute symptoms are beginning to subside, the testis should be strapped. The affected organ is separated from its fellow, and isolated by winding round above it a long narrow strip of soft leather covered with emplastrum plumbi. The end that is applied first should be narrower than the other, so as to prevent the edge cutting into the skin. Then narrow strips of ordinary plaster are arranged so as to cover the whole organ evenly, beginning from the horizontal piece in front, passing down round the bottom of the scrotum, and ending on it again behind. Afterwards a circular piece is placed over all the ends to keep them secure. If a small nodule obstinately persists, mercurial ointment may be rubbed in over it, or a thick layer of it may be applied upon lint under the strapping, but care must be taken that it does not irritate the skin.

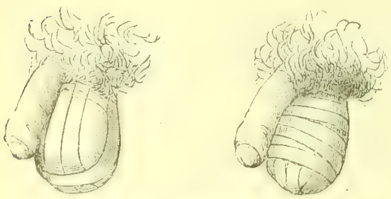

FIG. 461.—Strapping testicle

Traumatic orchitis may be treated in the same way. When due to metastasis warm fomentations are better from the first; and if there is much infiltration of the scrotum, so that the condition of the circulation is doubtful, or if the patient is old and feeble, cold should not be used for fear of gangrene.

2. Chronic Inflammation

This may begin as such or be the relic of an acute attack. When confined to the body of the testis it is nearly always due to syphilis; gout and malaria are exceptional causes. If the epididymis only is concerned, it is probably tubercular or urethral, and in the latter case it may be either the remains of an acute attack or chronic from the first. Syphilis occasionally affects the epididymis only (in the early secondary period), and, not unfrequently, both epididymis and testis.

The **diagnosis** is usually straightforward; but sometimes, when it commences insidiously, without any obvious degree of inflammation, involving the body of the gland, and not the epididymis, and affecting one side only, it is difficult to distinguish it from incipient malignant disease, except by watching the progress of the case and the effect of treatment.

(*a*) *Syphilitic Inflammation*

Subacute epididymitis may occur in the early secondary stage, a painful irregular swelling making its appearance at the back of the testicle, involving the cord to a slight extent. It never possesses the severity of urethral epididymitis; the skin may be reddened, but it is not œdematous; and, like the other secondary symptoms with which it occurs, it subsides rapidly under mercury.

True orchitis appears later, either during the intermediate period (when both glands are involved), or with the tertiary symptoms, when one is often attacked long before the other. As a rule it does not affect the epididymis or the cord, and is very chronic in its progress; but often, in neglected cases, after the first testicle has been enlarged for some time, the second suddenly becomes acutely inflamed, the skin grows hot and red, the tunica vaginalis distended, the epididymis affected as much as the testis, and the pain so severe that the patient is compelled to apply for relief.

Symptoms.—The character of the swelling depends upon the distribution of the syphilitic exudation, and the changes it undergoes. In some cases, especially the earlier ones, there is uniform enlargement of the whole gland, so that it remains ovoid, smooth and even, and merely becomes heavy and intensely hard; in others the surface is nodular and uneven in consistence, dense indurated patches alternating with others that are soft and elastic. The exudation, in other words, may be uniformly distributed throughout the whole of the fibrous tissue of the gland; or aggregated either into one central gumma or into numerous scattered ones of various sizes; and, according to the success of the treatment, it may be completely absorbed, merely leaving a slight depression, or become organised into cicatricial bands, or break down and undergo caseation and liquefaction. Occasionally this ends in suppuration and hernia testis; more frequently partial absorption takes place, and a hard irregular mass is left, sometimes in the middle, sometimes at one side of the testis, composed of a caseous or even calcareous centre, surrounded by an immense thickness of cicatricial tissue—a so-called chronic abscess.

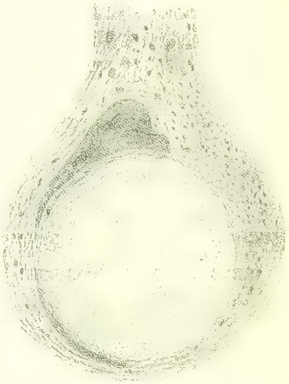

FIG. 462.—Syphilitic disease of testis; a central gumma.

The size a testicle may reach under these conditions is something enormous; usually when large it is painless and devoid of testicular sensation. Heat, redness, thickening of the cord, œdema of the skin, and effusion into the tunica vaginalis, are signs of acute inflammation, and are only present when the testicle is first attacked, or when a fresh gumma suddenly develops. I have known cases of this kind last for over ten years, with occasional subacute attacks compelling the patient to apply for relief, until at length the testicles were enormously enlarged, irregular in shape, hard, painless, and absolutely devoid of sensation.

The **diagnosis** of syphilitic orchitis is rarely difficult; the only form that resembles it is that which occurs in gout. The chief features are the essentially chronic character of the affection (varied from time to time by more acute attacks); the smooth, hard, heavy character of the swelling; the disappearance of the epididymis, which in many instances is so flattened out that it cannot be felt (occasionally it is enlarged); the absence of pain (during the greater part of the time), and of testicular sensation; and the fact that both testes are involved, though rarely equally.

Treatment.—In epididymitis and recent orchitis, mercury may be given freely with a view of causing speedy absorption; later, especially if the disease has relapsed, more benefit is derived from small doses of bichloride, continued with occasional breaks. Iodide of potash always causes a rapid diminution in size, but absorption of the syphilitic exudation is rarely complete; it progresses up to a certain point, continues as the dose is increased, and then comes to a standstill, leaving a dense mass, over which nothing appears to have any influence. The acute symptoms, however, are quickly relieved by it. Occasionally other remedies are of service: mercury, for example, rubbed into the skin on the inner side of the thigh (it cannot be applied to the scrotum); strapping; or the removal of hydrocele fluid. If suppuration occurs, the abscess must be opened; and at length, if the testis becomes useless, and is a constant source of pain and suffering, castration may be advisable.

(*b*) *Tubercular Disease*

This is most common about puberty and in young adult life, although it may develop at any age, and it may be either primary, and followed by extension to other organs, or secondary, sometimes occurring as part of general tuberculosis. Except in this case (which from the condition of the patient rarely admits of diagnosis during life) it always begins in the epididymis as a deposit of grey miliary tubercle in the lymphoid intertubular tissue. From this it may spread into the body of the gland, working its way through the mediastinum testis, and infecting the lymphoid tissue around the tubuli seminiferi; or up the vas, to the vesiculæ seminales, prostate, and bladder; or it may, under happier circumstances, after attaining a certain size, gradually cease to enlarge, and either discharge itself externally as a mass of caseous débris, or undergo calcification or fibroid degeneration. One side is usually attacked first, but it rarely happens that the other remains exempt for long.

Symptoms.—The beginning is rarely noticed: a hard nodule, already of some size, is usually discovered accidentally at the back of the gland. It is quite painless; there is no hydrocele, and scarcely any inflammation; it is only slightly tender even on pressure, and testicular sensation is not impaired. At first it may be rounded or irregular, but after a time it becomes crescentic, and grows out above and below the testis as well as behind. The gland itself is rarely affected at this stage.

Sometimes this diminishes in size, and becomes harder and more irregular, probably undergoing fibroid degeneration. More frequently it continues to increase; one part becomes softer than the rest; the skin over it grows red and adherent; then becomes thinner and thinner until it breaks, and gives exit to a turbid caseous liquid resembling pus. Occasionally even then the morbid process ceases; more frequently other deposits break down; more sinuses form; the testis and vas become involved; and at length secondary deposits make their appearance elsewhere. Hernia testis may occur, although it is not so common as in syphilis.

Diagnosis.—Urethral epididymitis is usually acute. Sometimes it is chronic from the first; but then there is seldom a real increase in size: there is merely a certain degree of induration, usually limited to the globus minor. The secondary syphilitic form disappears within a week or ten days under mercury. Cysts may cause a little trouble, but when they occur in connection with tubercular epididymitis they are never very large or distinct.

Treatment.—Constitutional measures are of the highest importance: in the early stage, when the diagnosis is still uncertain, or before the patient will allow an operation, they may succeed in arresting the disease; in the later, when there is no longer any hope of effecting a cure by local measures, they will often check it for a time. Perfect rest, especially avoidance of sexual excitement, is most important; sea-air, often a long sea-voyage, answers better than anything; the food must be nutritious; a moderate supply of stimulants allowed; and tonics, especially cod-liver oil, given freely.

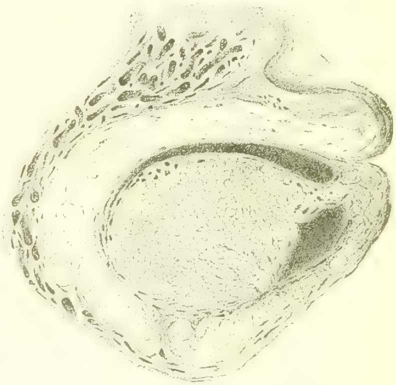

FIG. 463.—Tubercular disease of the epididymis with miliary deposit in the testis.

The local treatment depends upon the stage the disease has reached. If the globus minor is merely indurated, without there being any definite increase in size, as compared with the other one, or any distinct nodule, the condition of the urethra should be carefully examined, and the testis strapped over iodide of lead ointment. In most cases, however, this stage is already past, and there is a definite nodule, often commencing to soften, at the back of the testis, or even several of them. If the rest of the epididymis is free, and the vas not thickened, an attempt may be made to arrest the progress of the disease by laying it open, scraping out all the tubercular tissue, and plugging the cavity with iodoform. Such a state of things, however, is rare: nearly always the whole epididymis is affected, and the vas distinctly enlarged before the patient applies for treatment. Under these conditions, if the opposite gland is sound, and no enlargement of the vesiculæ seminales can be detected, the diseased organ should be removed at once, the vas being divided as high up as possible. When the disease is more advanced, much may still be done to husband the patient's strength; sinuses may be scraped out and filled with iodoform; the testicle carefully protected; the inflammation checked by lead lotion or belladonna; and if there is any serious amount of discharge, weakening or distressing the patient, or if hernia testis forms, castration may be performed.

(*c*) *Gouty Orchitis*

This is much more rare than either the syphilitic or tubercular variety, and in many of the cases in which it is assigned as the cause the evidence of gout is not so clear as might be wished. Subacute orchitis, however, is not uncommon in men past middle life, especially those of gouty habit, and occasionally is distinctly associated with gout. The testis itself is involved, not the epididymis; a certain amount of hydrocele is usually present; the pain and inflammation are severe, though not to the same extent as in urethral epididymitis; and some chronic induration is not unfrequently left.

In addition to this, subacute orchitis may occur in connection with urethral arthritis, hereditary syphilis, and possibly other disorders.

3. Suppuration

Acute orchitis, unless it is due to pyæmia, rarely breaks down and suppurates. In urethral epididymitis this termination is rather more common, but the abscess is seldom acute. Most cases arise in connection with syphilis or tubercle, suppuration either occurring around the caseous mass before it breaks the skin and makes its way out, or, after this has happened, in which case the pyogenic organisms may gain entrance through the wound. In any case the abscess should be opened as soon as possible and drained.

HERNIA TESTIS

Hernia testis, like hernia cerebri, is a protrusion of the substance of the organ through an opening in its unyielding capsule, due to inflammation. Suppuration is not essential to its production, but it is so uniformly present that it is usually regarded as the cause; the opening in the capsule might, however, be produced in other ways, and the increased tension in the interior and softening of the subjacent layers might arise from other causes, such as syphilis or tubercle.

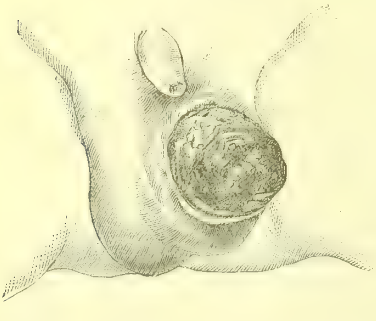

Fig. 464.—Hernia of the testicle following tubercular disease, removed from infant, æt. 2.

Hernia testis must be distinguished from 'malignant fungus' of the testis, or 'fungus hæmatodes'—the protrusion of a malignant growth through the coats; and also from what has been called 'false hernia'—a prolapse of the testis, covered with a layer of granulations, through an opening in the tunica vaginalis and scrotum.

In the majority of cases hernia testis is due to syphilis: a gumma forms in the substance of the organ and breaks down; the layers of the tunica vaginalis fuse with each other and with the skin; this grows thinner and thinner, until at last it gives way, exposing a cavity filled with caseous or sloughing débris, and lined by a still growing layer of syphilitic exudation. The external pressure is removed by the rupture of the fibrous wall, and if the syphilitic growth or the suppuration is active, a mass, sometimes of granulations, sometimes of the tubuli seminiferi themselves, is forced out through the orifice by the vascular tension. The same thing may occur with tubercle when this involves the testis, and with other forms of suppurative orchitis.

The appearance is characteristic. A soft red, granular mass, occasionally covered with sloughs or caseous débris, projects through an opening in the scrotum, to the margins of which it is closely adherent. In some instances it seems as if the whole testis is driven out, and the edges of the opening are everted and concealed beneath a mushroom-shaped mass; in others there is merely an open sore with protuberant granulations at the bottom. It does not bleed very readily (like the malignant form), and, as there is now no tension, is not very painful; but, particularly in the tubercular variety, it may prove a serious drain upon the patient's strength.

Treatment.—As in hernia cerebri, the first point is to stop the inflammation. If this can be done the protrusion soon subsides spontaneously; the wound becomes a granulating sore, and cicatrisation begins. Occasionally, if the surface is perfectly clean, this may be hastened by Syme's operation—removing the narrow edge of unhealthy skin around it by means of two elliptical incisions, one on each side, and drawing together the margins over it; but it often fails. In tubercular cases, in which the testis is practically destroyed and the caseous process will not cease, castration is usually advisable, not with a view of curing the patient so much as of relieving him of a source of infection and a constant drain upon his strength.

TUMOURS

Dermoid and *hydatid cysts* are occasionally met with. The former may be recognised by their congenital origin (though they often do not attain much prominence until late in life) and uneven consistence; but no certain diagnosis can be made without puncture.

Cystic adenoma is more common. Like parotid glandular tumour, it is peculiar to the organ from which it springs, and only admits of a somewhat vague comparison with other growths. It consists of cysts of all sizes, lined with cubical or flattened epithelium, filled with a clear brownish or greenish fluid, and developed from the tubuli seminiferi, the epithelium of which has either lost or has never acquired its distinctive characters. In between is a variable amount of fibrous tissue, sometimes undergoing myxomatous degeneration, and occasionally mixed with cartilage. Intracystic growths may occur as well.

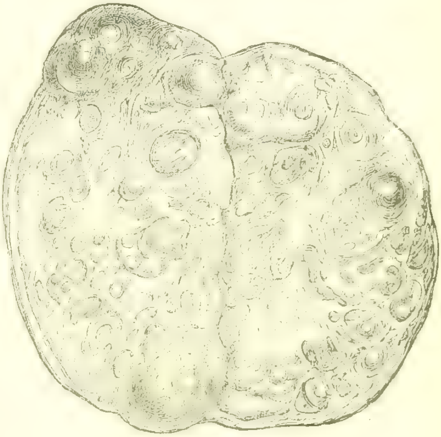

FIG. 465.—Cystic disease of the testicle.

Tumours of this kind may occur at any age, but they are rarely noticed before puberty. Growth is slow and painless, the patient suffering no inconvenience other than that due to the weight. The vas is never affected, and secondary deposits do not occur; the cases in which this is said to have taken place having really been sarcomata, with an accidental development of cysts.

Fibroma and enchondroma of the testis are met with in young adult life, but they are both very rare. The chief clinical feature is the slow growth of a hard and heavy painless mass. The surface is usually smooth, but it may be nodular and suggest the presence of cysts. Growths of this kind do not extend along the cord, invade other organs, or recur; but removal is always advisable. There is no means of distinguishing one from the other but by section.

Carcinoma of the testis is nearly always encephaloid, though a few cases of scirrhus have been described. It is stated to be most common between twenty and forty years of age. The beginning is usually very insidious: the testis is enlarged, smooth, ovoid, and at first fairly firm; the cord is not thickened, nor are its components matted together; but it feels fuller than the other, and the veins over the scrotum are distended. There is little or no pain or tenderness, and testicular sensation is soon lost. In a very few weeks there is a rapid increase in size; the tumour is softer; the surface uneven; the cord distinctly thickened; the shape becomes globular; and the epididymis flattened out at the back. If left it becomes so soft that it almost seems to contain fluid; the skin becomes adherent; the veins are more distended; the thickening extends higher up the cord; and, perhaps, if the patient is thin, an ill-defined sense of resistance can be made out, by deep pressure at the back of the abdomen. Soon the skin of the scrotum gives way, allowing a bleeding mass to protrude; the glands of the groin enlarge; secondary deposits make their appearance in other organs, and the patient sinks rapidly from exhaustion.

Sarcoma of the testis presents greater variety of appearance and character. It may be round-celled, or spindle-celled; and the latter especially may become more or less converted into cartilage (without however losing one atom of its malignant sarcomatous character); sometimes there are only nodules here and there; sometimes branching outgrowths, due perhaps to the spreading of the disease inside the lymphatics; and occasionally so much that the original sarcomatous growth is hard to find. In addition, both of these forms may be associated with cysts, due either to softening and hæmorrhages or to distension of the seminiferous tubules, with proliferation of the epithelium lining them, and occasionally intracystic growths, so that they may present a close resemblance to some of the forms of cystic adenoma.

Sarcoma may occur at any age, even before birth, though it is most common under ten and between thirty and forty. The round-celled variety, unless the patient is a child, or both testicles are attacked at once, cannot be distinguished from encephaloid carcinoma: the progress is as rapid, and the glands of the lumbar and other regions are involved as soon; if possible it is even more fatal. The other variety is much less uniform in rate of growth and consistence: it may, for example, be formed almost wholly of cartilage or fibrous tissue; cysts are less common; and it does not appear so ready to fungate; but the ultimate results, the infiltration of the glands with growth of the same histological character as the primary one, and the secondary deposits in the lungs and other organs, are equally certain.

Treatment.—Sarcoma and carcinoma should be removed as soon as the diagnosis is made, the cord being divided as high up as possible. The prognosis is very unfavourable, but in all probability this is due in some measure to delay : there is evidence to show that if castration is performed in time recurrence may not take place for many years. Even if the skin is involved, and the cord thickened, the operation is advisable to save the patient from the formation of a fungus, if only there is reasonable prospect of securing immediate union of the wound.

Diagnosis of Tumours of the Testes

Age.—A tumour that appears in infancy is probably hydrocele: sarcoma, syphilitic and tubercular orchitis do occur, but they are very rare in comparison.

Etiology.—A definite history of accident deserves consideration, though it may have merely drawn attention to an already existing but unsuspected enlargement. Sarcoma may follow injury as well as hæmatocele.

Rapidity of growth.—Hæmatocele is an affair of minutes, or at most of hours, malignant disease of a few weeks. Acute orchitis presents no difficulty ; chronic inflammation, on the other hand, if only one side is involved, if there is no evidence of constitutional complaint, and if there is but little heat or pain, and no redness, can often only be diagnosed by the results of treatment. Syphilitic orchitis, for example, may, so far as a single examination is concerned, be indistinguishable from incipient malignant disease.

Duration.—If the tumour has lasted more than six months, without the doubt clearing up, it is not malignant.

Consistence, whether solid or fluid. Hydrocele and hæmatocele are the only fluid tumours at all common, but there are many sources of fallacy. A hydrocele may conceal an enlargement of the testis (hydrosarcocele). Old hydroceles and hæmatocele may have walls of such thickness as to appear solid ; and rapidly growing malignant tumours may be as soft and elastic as if they contained fluid.

Translucency.—This separates off at once thin-walled hydroceles.

Number.—Hydrocele and sarcoma may occur on both sides, but nearly always, when both testes are affected, the tumour is of inflammatory origin.

Shape.—If the tumour retains the shape of the testis, it is probably either chronic inflammation or incipient malignant disease. Sarcoma and carcinoma when more advanced, hæmatocele and encysted hydrocele, are spherical ; other tumours are very irregular.

Pain and sensitiveness.—Hæmatocele may be very painful at first : the others (except acute inflammation) are rarely attended by pain. In chronic orchitis, malignant disease and hæmatocele, testicular sensation soon disappears.

The condition of the cord.—In chronic orchitis, hydrocele and hæmatocele, the cord is not affected. In acute inflammation and incipient malignant disease it feels full because of the increased amount of blood. In acute epididymitis and advanced sarcoma and carcinoma, it is thickened and all its component structures welded together. The vas itself is enlarged in tubercular epididymitis.

The skin is not adherent unless there is acute inflammation or advanced malignant disease.

Hæmatocele can only be distinguished from incipient malignant disease by the rapidity of its development, its history, or the result of puncture. Even this, however, may deceive: on one occasion I tapped a blood-cyst in the centre of a sarcoma.

Chronic orchitis in some cases can only be diagnosed from incipient malignant disease by the effects of treatment; but not more than a fortnight should be allowed.

CASTRATION

A linear incision from the external abdominal ring down to the bottom of the scrotum is all that is required, unless, as in the case of a malignant growth, or of hernia testis, the cutaneous coverings are adherent to the deeper structures. The skin should be made as tense as possible to avoid any jagging, and the cord exposed at once. As soon as this is isolated the testis can be protruded through the wound. In the case of malignant disease or tubercular infiltration, the inguinal canal should be slit up on a director, and the cord drawn down as far as possible before securing it.

The usual method is either to pass a single ligature round the cord (silk should be used) or to tie each vessel separately as it is divided, leaving the vas to the last. As, however, the ligatures may slip in both of these, causing severe and deep bleeding when the cord retracts, and as the latter is very tedious, Jacobson recommends that a double ligature should be passed through the substance of the cord, the loop cut, and the two halves tied separately. Then the ends of the one are cut short, while the other is tied again round the whole thickness. If possible the cord should be divided well above the disease. No drainage-tube is necessary if the dressing is carefully arranged around the wound.

The testis should always be examined before the cord is tied, in case of a mistaken diagnosis, and the cord should never be divided until it is certain that the ligature is secure.

VARICOCELE

By this is understood a varicose condition of the veins of the spermatic cord, often associated with a diminution in size and loss of tone of the testis, and a peculiar flabby relaxed condition of the dartos. It is very much more common on the left side than the right, and if it occurs on both it is always worse on the left.

Etiology.—It is rarely or never noticed before the period of functional activity of the testis, and is probably the result of some developmental defect. The various causes that have been assigned, the length and direction of the veins, their imperfect support, and the vascular changes that attend too early intercourse, or abuse, act on both sides alike; and the reasons given for the predominant frequency of the left—the pressure of the sigmoid flexure, the greater length of the veins on that side, and the opening into the renal—are insufficient, as causes, though they may make the condition worse. The valves in the veins are thoroughly competent.

Symptoms.—These bear no relation to the size; a very large varicocele may exist without the patient knowing it. Complaints are most common in young adult life, or much later, when sexual power is failing. There may be tenderness and irritability of the testis, sometimes amounting to severe pain; but the chief feature is a constant dragging and weight in the loins, made worse by standing, exercise, constipation, or sexual intercourse—anything in short that increases the congestion. With this there is frequently associated a most distressing mental condition ; the patient is subject to periods of intense depression ; he is always thinking of himself; often he believes that he is failing in power from some old indiscretion ; and not unfrequently he becomes a confirmed hypochondriac at last.

The skin of the scrotum is so lax that the testicle hangs far below its proper level ; the cord is surrounded by a soft irregular mass of dilated veins (like a bag of worms) obscuring the gland below, and ceasing at the abdominal ring ; and the testis itself is often small, soft and flabby. There is a distinct impulse on coughing ; the veins empty themselves spontaneously as soon as the patient lies down and the scrotum is raised ; and if, after this, he stands up again they gradually refill from the bottom in spite of firm pressure over the ring.

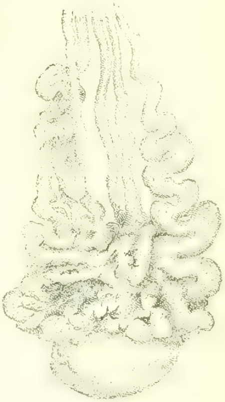
FIG. 466.—Varicocele.

Allusion has already been made to the relation between the testis and the varicocele : the morbid condition in both is probably dependent upon the same cause. Size has very little to do with it : a very large varicocele may coexist with a well-developed testis ; but as the testis is frequently ill-formed, soft and flabby, and as it increases in size and firmness after operation, it is clear that the enlargement of the veins must help to perpetuate the condition, though it may not originate it. Where one testicle only is affected there is no means of judging of the effect upon the seminal secretion ; but there is reason to believe that sometimes at least, when both are, it is defective, and only becomes active when the testes assume their normal size and consistence.

Treatment.—In the vast majority radical measures are entirely out of place : varicocele seldom causes inconvenience after early manhood is past. A suspender should be worn, one that is not too hot or complicated ; the parts should be bathed with cold water night and morning ; the bowels opened regularly ; a fair amount of exercise taken, and stimulants, sexual excitement, &c., avoided. It is only when the health is out of order that the weight of the part is noticed. Occasionally, however, this is not sufficient : the patient may wish to enter one of the Services ; both sides may be involved ; the varicocele may be serious from its size, the rapidity of its enlargement, or the danger of rupture or phlebitis (which is not uncommon in connection with gout) ; the testis may be irritable and tender, or the patient very much troubled about its condition. In those cases in which there is any reason to fear the development of hypochondriasis, every endeavour must be made to divert the patient's attention from the subject ; but too often the attempt ends in complete failure, and though the prospect is not an inviting one, there is no alternative. Pearce Gould considers operation advisable in all cases in which varicocele develops before puberty.

Operation.—The older method, in which a ligature was passed round the veins subcutaneously in one or more places, is practically abandoned : the result is uncertain, and there is great risk of transfixing a vessel. Even the addition of subcutaneous section does not increase the security. The method ordinarily adopted is to expose the veins freely, so that the structures to be dealt with can be seen; isolate the vas deferens with the spermati artery, ligature the vessels above and below, and excise the intermediat portion. Pearce Gould, however, considers subcutaneous section with th cautery preferable.

The patient is placed under an anæsthetic, the parts shaved and cleansed and an incision of sufficient length made along the cord, exposing the fasci which surrounds the veins. The vas is then carefully separated at the back taking care not to isolate it, but to leave the fascia around it untouched; catgut ligature passed round the rest of the fascia and the veins above, second below, and the intervening portion excised. Practically, if th separation is commenced above, all the veins are included but one or tw little ones with the vas. The length to be excised depends, as Bennett ha shown, upon the height to which it is wished to raise the testicle; and afte excision the two cut ends should be sutured together so that the shortenin of the fascia may help to support the gland. No drainage-tube is neede unless there has been much handling. The swelling afterwards is considerable, and the testis may be a little tender, but I have never known orchiti follow. An ice-bag may be applied for forty-eight hours as a precaution The patient should remain in bed for ten days or a fortnight, by which tim the induration will have disappeared, and should wear a suspender for som months.

HYDROCELE

Hydrocele is a general term for a collection of serous fluid in connection with the testis or its coverings. It may be developed from th tunica vaginalis, or from the testis or epididymis; occasionally both occu together.

1. *Hydrocele developed from the Tunica Vaginalis*

Of these there are various kinds, according to the part in which th fluid collects; the common example is hydrocele into the tunica vaginali propria testis. It may be acute or chronic.

Acute hydrocele is usually secondary to inflammation of the testis o epididymis, but it may be caused by direct irritation of the tunica vaginalis. Its symptoms and treatment present nothing special: it may subside, leaving the sac more or less obliterated, or become chronic, or suppurate and form an abscess in front of the testis.

Chronic hydrocele, too, may be secondary; and occasionally it i associated with the presence of a pedunculated growth in the interior of th sac, or with elephantiasis; but in the majority there is very little evidence o irritation or inflammation. It occurs either in infancy or in commencing old age, when the functional activity of the gland is on the decline. In th former case it is probably originated by the changes that attend the descen of the testis, and kept up by the tension; the cause, at any rate, is no persistent, for the hydrocele, once emptied, seldom returns; in the latter i is more likely that there is some slight irritant, possibly constitutional, fo the fluid nearly always collects again if it is removed, and both sides ar often affected. At other times of life, hydrocele, for such a common affection, is decidedly rare.

Symptoms.—Chronic vaginal hydrocele forms a smooth, ovoid, or pear-shaped swelling, more or less tense, completely concealing the testicle.

There is no impulse on coughing, the cord above it is distinct, and the inguinal canal free. It begins below, slowly extends upwards, and may reach an enormous size ; fluctuation is distinct (unless it is too tense), and in the vast majority of cases the swelling is translucent. There is no pain or tenderness, merely a sense of dragging on the loins, owing to its weight ; but if firm pressure is made behind, on the lower part, testicular sensation is usually felt. It is absolutely essential to make out the position of the testis (it may have been inverted in its descent, so that it lies in front, or dragged in various directions by old adhesions), but this may be done with much less discomfort to the patient by examining the swelling with transmitted light. The patient should stand upright, with a light held on the side on which the hydrocele is ; the back part of the scrotum and the other testicle should be grasped with the left hand and drawn down so as to make the skin as tense as possible, and the light shaded off with the right, which at the same time keeps the penis out of the way. The red glare can be recognised at once, the testis appearing as a dark shadow. If there is any difficulty, a roll of paper may be used as a tube to keep off outer rays.

Variations are not uncommon. Hernia or encysted hydrocele may be present. The shape may be complicated, owing to adhesions or sacculi ; the fluid may have accumulated rapidly, with severe pain ; translucency may be lost, owing to the addition of blood, and the walls may have become thickened from chronic inflammation. Old hydroceles are especially deceptive : they are often perfectly globular, like a hæmatocele or malignant tumour of the testis ; the walls are half an inch or more in thickness, with calcareous plates inside them, and the contents are milky and semi-solid with fatty matter and cholesterin ; they are perfectly opaque ; there is no sense of fluctuation, and even if they are tapped it is difficult to get a sufficient amount of fluid out of them for purposes of diagnosis. Practically they can only be distinguished by their history, or by exploration.

Diagnosis. *Hernia.*— Unless it is strangulated there is always an impulse on coughing ; a hernia is never translucent, and the swelling always extends through the abdominal ring. An irreducible epiplocele associated with hydrocele may cause some difficulty, but if the swelling is grasped between the finger and thumb while the patient coughs, the impulse can be felt in one part and not in the other.

Hæmatocele and *tumours of the testis* are never translucent. Old hydroceles are, it is true, not translucent either, but in all of these exploration is essential.

Inflammatory affections of the testis.—Acute inflammation cannot easily be mistaken ; chronic orchitis, on the other hand, attended with hydrocele (hydrosarcocele) may be very difficult : the fluid invests the testis completely, and the state of the gland cannot be ascertained until this is withdrawn.

The other forms of hydrocele into the tunica vaginalis are associated with congenital defects.

(*a*) In *congenital hydrocele* the tunica vaginalis still communicates with the abdominal cavity. This is more common on the right side than the left, and usually occurs in children, although it may be met with at any age. It is distinguished by the swelling disappearing when the patient lies down and the sac is gently manipulated (some care is required, as the neck is usually long and tortuous) ; by an impulse on coughing (when the communication is sufficiently free); and by the variations in its size. It may or may not be associated with congenital inguinal hernia; the pressure of a truss is usually sufficient to procure obliteration of the neck.

(*b*) In *infantile hydrocele*, the communication is shut off in the inguinal canal, but nowhere else, so that when the sac is distended it forms a pear-shaped swelling, the smaller end of which extends up to and sometimes into the external abdominal ring. Old hydroceles of the tunica vaginalis testis occasionally imitate this, owing to the yielding of the upper part of the sac. It occurs in infants, but is by no means confined to them, and requires the same treatment as the ordinary form.

(*c*) In *encysted hydrocele of the cord* the communication is shut off in the normal manner above and below, but the intermediate (funicular) part of the serous sac is not obliterated. It may form a sausage-shaped swelling in the cord in front of the vas; or a chain of separate rounded cysts, or a single one; and it may be immediately above the testis, so as almost to seem part of it, or in the inguinal canal, simulating a bubonocele. It is always translucent (when large enough) and tense, and it is distinguished at once by its moving with the cord.

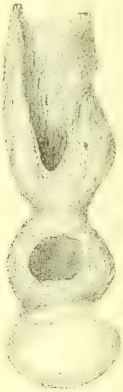

Fig. 467.—Encysted hydrocele of the cord.

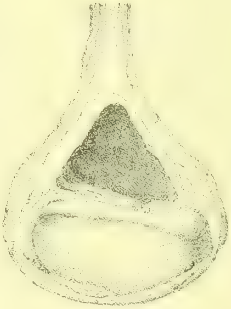

Fig. 468.—Spermatocele.

2. *Hydrocele developed in connection with the Testis or Epididymis*

Encysted hydrocele of the testis.— Small cysts may be formed in the tunica albuginea, or late in life in the epididymis, but these are of no surgical importance: the former are very rare, the latter scarcely admit of recognition. A different kind is occasionally found attached to the epididymis, developed in all probability from a rudiment of the non-sexual part of the Wolffian body, and corresponding, therefore, to the parovarian cysts in the female. Usually it is single, and of no great size; but it may be multiple, or it may reach along the cord and simulate encysted hydrocele developed from the tunica vaginalis. When small its contents are clear and albuminous, effervescing with acetic acid, from the presence of alkaline carbonates. As it grows larger, and presses upon the neighbouring tubules, these not unfrequently rupture into it, so that it becomes filled with spermatozoa. Sometimes these are still living when the cyst is tapped; more frequently they are dead and motionless, but their presence is almost certain when the contents on their exit are milky white and opaque (*spermatocele*). Occasionally cysts of this kind are associated with the common form, and sometimes the partition wall becomes so thin that a communication forms at last.

Treatment.—Congenital hydrocele, whenever it appears, is a prolongation of the peritoneal cavity, and must be treated as such; a truss may be applied, and if this does not succeed the neck may be ligatured.

Hydrocele (other than congenital), occurring in infancy, usually gets well of itself. If it does not, lead lotion may be applied; or the swelling may be pricked (acupuncture) or tapped. Very few require anything more.

Later in life, if the tumour is of any size, it should be tapped. Occasionally it does not refill: much more frequently the fluid collects again, and if it is tapped a second time comes back more quickly than before. Whether the patient should rest content with temporary relief of this character, or undergo what is known as the 'radical cure,' must depend upon his age, the state of his health, his occupation, and the amount of inconvenience he suffers. The operation is not a serious one in itself; but it may not be worth his while.

Tapping.—An ordinary trocar and cannula of small calibre is used, taking care that it is thoroughly clean and well oiled. The patient should be seated on the edge of a chair, with the knees separated, and the position of the testicle ascertained. The scrotum is grasped from behind with the left hand, so as to stretch the skin tensely over the swelling, and a spot selected on the front (in all ordinary cases), between some of the large scrotal veins. The trocar is held in the right, the thumb or forefinger being placed on it about half an inch from the point, so as to limit the amount of penetration, and entrance effected with a quick and firm thrust. As soon as the point of the instrument is in the cavity the hand should be dropped, so as to direct it upwards away from the testicle. The whole of the fluid should be removed and the little puncture covered with some dry lint. The patient should wear a suspender afterwards until the dartos has recovered.

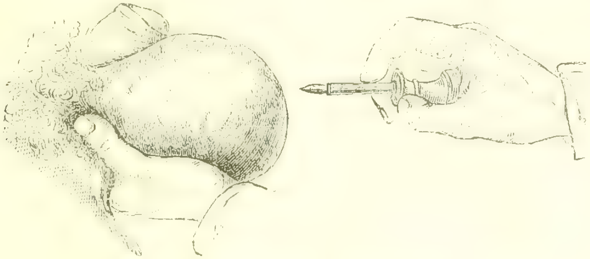

Fig. 469.—Tapping a hydrocele.

Acupuncture, piercing the sac with a harelip-needle, and freely scarifying the interior, is chiefly suited to encysted hydrocele and the forms that occur in infancy.

Injection.—Tincture of iodine (℥ss, pure, or with an equal quantity of water), is commonly used. The sac is emptied thoroughly, the fluid injected through a glass syringe (taking care that none enters the cellular tissue), and then, after being manipulated so as to bring it into contact with every part of the interior, allowed to escape again. Subacute inflammation at once sets in, with in many cases very severe pain, confining the patient to bed for some days. The skin becomes red; the sac refills; and even the testis may be affected. At the end of a week this should begin to subside, and in a fortnight the whole should have disappeared, and the sac should have resumed its normal size, merely leaving a little thickening at the back of the testis. Occasionally, even when cure is permanent, no visible change is produced in the sac; more often a few adhesions form; and sometimes the sac is completely obliterated (fig. 470). Failure occurs in at least one-third.

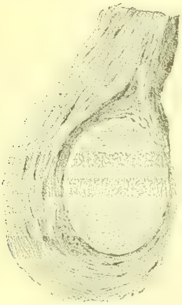

Fig. 470.—Obliteration of the tunica vaginalis after injection with tincture of iodine.

Carbolic acid (♏ xx, with glycerine), corrosive sublimate (gr. $\frac{1}{32}$), and iodoform may be used instead of iodine. The pain is less severe; if the sac is a small one, it is not necessary to confine the patient to bed, and the results are as good.

This method is chiefly suited to small hydroceles of the tunica vaginalis that have not been tapped many times: it should not be employed if there is any reason to suspect chronic orchitis; if the walls of the sac are thick; if the size is large; or if the patient is old and broken down in health.

Incision.—The tunica vaginalis is laid open; the edges sutured to the skin; and a drainage-tube passed down to the bottom. This plan (using Lister's dressings) was introduced by Volkmann with the view of procuring direct union; but it is uncertain; it necessitates confinement to bed; and sometimes it leaves a persistent sinus.

Partial excision, removing the parietal portion of the sac, is much more satisfactory. A free incision is made down to the tunica vaginalis, the sac emptied, and as much as is thought desirable cut away with scissors, avoiding large veins and leaving the covering of the epididymis and cord. No vessels require ligature; the wound is sewn up; a drain is inserted; and the dressings arranged so as to obliterate the cavity and ensure primary union. If enough is removed the sac cannot refill; there is no pain afterwards, and one change of dressings is usually sufficient.

In old hydroceles with thickened walls this is the only method; but in many of these the patients are already aged and broken down; the tissues are badly nourished and prone to slough; the testis can hardly be isolated without bruising; and it is a question whether castration is not preferable. The risk is certainly less.

Hæmatocele

By this is understood an effusion of blood into the tunica vaginalis or a cyst of the epididymis or testis. In addition, a form of diffuse hæmatoma has been described in connection with the spermatic cord.

(*a*) Hæmatocele into the tunica vaginalis propria testis is the usual form; all others are very rare. It is always the result of injury—blows, strains, the sudden emptying of a hydrocele sac reducing the pressure upon the vessels, or the puncture of a vein in tapping a hydrocele; but, for various reasons, it is very much more likely to occur when there is a pre-existing hydrocele than when the structures are sound and healthy. Its contents may be pure blood, or a mixture of blood and serum; coagulation usually follows, and after a time the clot breaks down, forming a turbid chocolate-coloured fluid, which becomes lighter and redder when exposed to the air. At first the sac itself is but little changed, but as time passes the walls become thickened, partly from the deposit of lymph around, partly from the deposit of fibrin mixed with ordinary coagula (almost as in an aneurysm), in the interior, until at length the testis is completely buried, and all sense of fluctuation lost.

Hæmatocele developed suddenly in a previously healthy sac is usually globular: when it follows a hydrocele the shape depends on this. In either case it forms a smooth, tense, and elastic swelling perfectly opaque, concealing the testicle and not involving the cord. Fluctuation is rarely distinct: at first the sac is too tense; later, the blood coagulates and the walls become thickened. Signs of bruising and extravasation may be present for a time; and inflammation may follow, and even run on to suppuration; but the chief distinguishing feature is the rapidity of its formation.

The **diagnosis** must be made from tumours of the testis and old cases of hydrocele with thickened walls. In the absence of history that can be relied upon, exploratory incision is necessary.

(*b*) Hæmatocele into the funicular portion of the tunica vaginalis is very rare, and can only be diagnosed from encysted hydrocele of the cord by the history and the opacity of the swelling.

(*c*) Hæmatocele of the testis or epididymis must be distinguished from the corresponding form of hydrocele in the same way.

Treatment.—If the case is seen at once, an attempt must be made to limit the extravasation by means of cold, rest, and pressure. Afterwards, when there is no fear of further hæmorrhage, the size of the swelling should be reduced by tapping, and strapping applied, in the hope of causing absorption of the more solid portion. If this fails, or if the case is not seen until it has already lasted some time, an exploratory incision should be carefully made into the front of the swelling (the position of the vas deferens will usually give a clue to the relation the sac bears to the testis), the contents turned out, and all the fibrin dissected off. As this operation is a very tedious one, likely to be followed by extensive sloughing (the vitality of the sac and of the layers that line it is very low), and exposes the testis to considerable danger, the question arises, as in the case of old hydroceles, whether castration is not better for the patient.

CHAPTER XXV

DISEASES OF THE FEMALE GENERATIVE ORGANS

By J. A. Mansell Moullin, M.B., M.R.C.P.

Inflammation of the Ovaries and Fallopian Tubes

Inflammation of the Fallopian tubes may be acute or chronic. It rarely occurs as a primary affection: nearly always it is due to extension from the lining membrane of the uterus, sometimes from the ovaries.

Causes.—Gonorrhœa; inflammation after labour or miscarriage; the application of caustics to the interior of the uterus; anything, in short, that is liable to set up endometritis may cause it. The chronic form is usually associated with degenerative changes, cystic or cirrhotic, of the ovaries; but it is uncertain what relation these affections bear to each other.

Pathological appearances.—In acute cases the tube is swollen, softened and engorged with blood; its inner surface covered with a flocculent muco-purulent fluid. Being loosely attached to the upper border of the broad ligament, it tends by its weight to sink lower in the pelvis, partially covering over the ovary. The surrounding peritoneum becomes inflamed and covered with lymph, glueing adjacent organs together.

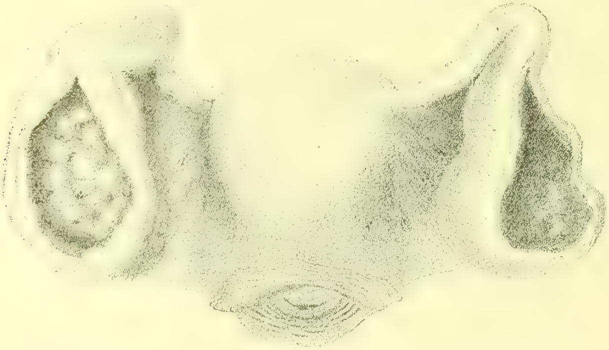

Fig. 471.—Inflammation of the Fallopian tubes; saccular dilatation laid open.

In long-standing cases, especially those in which the acute attacks have recurred, the parts become utterly disorganised and indistinguishable. At an early stage the fimbriæ become glued by adhesive peritonitis to each other, or to the ovary, or to some neighbouring part, and the outer opening is thus sealed. The secretion may find an exit through the uterine opening, but in many instances this also becomes occluded, either by some valvular fold or the contraction of the inflammatory deposit in its walls. The tube thus becomes enormously distended by the retained secretion, forming a cyst containing several ounces, and presenting a more or less convoluted and pyriform shape. According to the character of the fluid distending the tube, it is known by the names of *hydro-, pyo- or hæmato-salpinx.*

Symptoms, in recent cases, are those of peritonitis. In the chronic form, which comes more frequently before our notice, the symptoms apart from the history are exceedingly vague. Pain is always present, a constant dull aching in the inguinal regions, extending to the sacrum and down the thighs. It is much aggravated by locomotion, and only partially relieved by rest, the patient waking with it in the morning. Menorrhagia is very constant, and the pain which has been present all along is much intensified at the time of the catamenia. Dyspareunia and pain on defæcation are almost always present. Sterility is the natural result of the tubes on both sides being simultaneously affected. A most characteristic symptom is the recurrence of local peritonitis, time after time, without a definite reason. In recent cases, while the pain is severe, all that can be made out is a certain degree of fulness in the broad ligament, with extreme tenderness and fixation of the uterus. Later, as the attack subsides, bimanual examination may reveal a fulness in the region of the tube ; sometimes it forms a distinct rounded tumour with a clear sense of fluctuation ; sometimes, according as distension is present or not, a rounded band like an adhesion. The distended tubes are often prolapsed into Douglas' pouch. Whether clear serous fluid or pus is present can only be conjectured.

The Prognosis is very grave. Even if nothing worse happens, the patient is reduced by constant suffering to the condition of a chronic invalid. General peritonitis may supervene at any time from extension of the inflammation or rupture of the tube. Pelvic abscess may occur, and if by chance conception should take place, the puerperal state will be accompanied by the gravest dangers.

Treatment.—Acute inflammation must be treated as acute local peritonitis ; it may subside, resolution and absorption taking place, or become chronic. In the latter case, if the pain continues or the attacks recur with severe local symptoms, the uterine appendages with the ovaries should be removed.

Oöphorectomy. Removal of uterine appendages.—The preparation of the patient is the same as for ovariotomy, and the incision in the linea alba made in a similar manner. It should begin three inches below the umbilicus and run downwards for two inches and a half. The fundus of the uterus is felt for first and the broad ligament followed until the ovary is discovered. As soon as this is found and freed from adhesions, it is drawn up and the pedicle transfixed with a double ligature and tied. The ovary and tube are then cut away and the opposite side explored and treated according to circumstances.

If there are no adhesions, or merely recent ones, there is little difficulty, but in long-standing cases, when all the tissues around are matted together by adhesions, it may be impossible to distinguish one structure from another, or to free the ovary and tube sufficiently to bring them to the surface. The tubes should be ligatured as close to the cornu of the uterus as possible. The remaining steps of the operation are dealt with according to ordinary principles.

Ectopic Gestation

Ectopic gestation signifies the development of a fœtus elsewhere than in its normal situation in the cavity of the uterus. There are many varieties of this displacement, but probably they all arise in the first instance from arrest of the ovum in its passage along the Fallopian tube. Nothing is known as to its causation. A plausible explanation suggests that the normal ciliated epithelium lining the tube having been destroyed by antecedent inflammation, there is nothing to prevent the entrance of spermatozoa into the tube, or check the natural tendency of the fertilised ovum to adhere to the first surface it meets.

It forms at first a spherical or ovoid swelling by the side of the uterus, which undergoes sympathetic hypertrophy and forms a decidua, as in normal pregnancy. About the eighth or tenth week of fœtal life the walls of the tube rupture at the site of the placental attachment.

It must be remembered that the Fallopian tube is held in place by a fold of peritoneum which, after passing round it, is united loosely to itself by cellular tissue, forming a mesosalpinx. There is thus a narrow strip of tube running in an axial direction along the line where the two layers meet without any covering of peritoneum. As the tube becomes distended by the growing ovum, these layers tend to separate and this uncovered surface to increase in width.

The site of the rupture, according to Tait, is the leading feature, not only of the future pathological changes, but of the clinical progress and treatment of the case. If the rupture occurs in the part covered by peritoneum, as it usually does, the patient is almost certain to die from hæmorrhage unless prompt surgical assistance is at hand. If rupture occurs into the broad ligament, in many instances the ovum does not die, and the hæmorrhage is controlled by the fact that the blood pours into a mass of cellular tissue. The development of the ovum may go on to full term in its new situation between the layers of the broad ligament, and be extra-peritoneal.

When the ovum is arrested in that part of the tube which opens into the uterus, the period of rupture is usually delayed. This variety of gestation has been termed 'interstitial.'

Symptoms and diagnosis. 1. *Prior to rupture.*—Usually there is a history of previous sterility of longer or shorter duration. Then, about four weeks after pregnancy has commenced, the patient begins to complain of constant pain in the lower abdomen, with, at frequent intervals, violent exacerbations, causing intense prostration. At the same time there is great tenderness all over the iliac and hypogastric regions. On examination a small rounded tumour, exceedingly tender on pressure, is found by the side of the uterus. This indicates nothing more than distension of the tube, but if, in the course of a week, it enlarges considerably, the symptom becomes of great significance. No ordinary pelvic tumour grows with such rapidity.

As time passes, the ordinary signs of pregnancy make their appearance, with, in addition, irregular uterine hæmorrhage, the decidua coming away sometimes in shreds, sometimes whole, so as to simulate miscarriage. The uterus enlarges, but remains empty; the os is soft and patulous and the body displaced to one side.

2. *Rupture.*—This usually occurs during some slight effort. All of a

sudden the patient is seized with the most intense pain ; there is a sensation of something giving way inside, and collapse follows at once. Death may be almost immediate, or the patient may rally and peritonitis set in In the latter case a second rupture, to which the patient generally succumbs, may be anticipated before very long.

3. *If rupture does not take place, or does not prove fatal.*—The signs of pregnancy become more marked ; a tumour develops in the abdomen, lying to one side, with perhaps the uterus in front ; the pain and colic become less severe ; the fœtal heart can be heard and movements felt. If the case progresses to full term, labour pains set in, sometimes more than once, with a blood-stained discharge from the uterus, and the child dies, very often after a violent attack of convulsions.

After the death of the fœtus the tumour ceases to increase. Generally decomposition and suppuration set in, and, if the patient does not die from septic absorption or pyæmia, the débris gradually makes its way out through the abdominal wall, or the intestine, vagina, or bladder. Sometimes the dead fœtus remains quiescent for years, and occasionally it becomes converted into a calcareous mass or into adipocere.

Treatment. 1. *Before rupture.*—Attempts have been made to arrest the development of the ovum by various means, including the electric current. One electrode is applied as near the cyst as possible in the vagina, the other to the abdominal wall, and an interrupted current passed through as strong as the patient can endure. Great success has been claimed for this proceeding, but it must be remembered that cases of mistaken diagnosis are not uncommon at this early stage, that the muscular contraction induced by the current may itself cause rupture, and that even when the ovum is killed all danger is by no means over. In comparison with this, abdominal section offers manifold advantages.

2. *At time of rupture.*—The symptoms pointing to internal hæmorrhage, the proper course to pursue is to open the abdomen, secure the broad ligament at once to control the bleeding, remove the cyst, clear out the débris as thoroughly as possible, and drain the peritoneum. If the sac cannot be removed, it should be laid open, the fœtus extracted, and the walls stitched to the parietal peritoneum.

Interstitial gestation, unless the rupture takes place into the uterus, can only be treated by supra-vaginal hysterectomy.

3. *If the fœtus survives the period of rupture.*—The question arises whether operation should be performed at once, or whether it should be postponed with the view of extracting a living child. It depends upon the risk the mother runs before and during the operation. Tait holds that it is not materially increased by delaying operation ; but this view is not shared by others.

The patient is prepared in the same way as for ovariotomy, and the same incision is made. The fœtus may be found either free in the abdominal cavity, or enclosed within a sac. If the latter, the sac must be laid open, avoiding if possible the placental attachment, and the fœtus extracted. The sac itself is then removed, or, if this is impossible, the edges secured by suture to the parietal peritoneum and skin. The chief difficulty which presents itself to the surgeon is the management of the placenta. Opinions are divided as to whether it should be allowed to remain *in situ*, or an attempt made to remove it. It must be remembered that it is attached to the interior of a morbidly vascular cyst, and covers a large surface. An attempt to remove it may be followed by severe hæmorrhage, and no contraction of the cyst can be expected to follow its expulsion, as is the case in normal pregnancy. The advantages of removing it are, however, so obvious that it should be extracted if possible. There may be no difficulty, and if the hæmorrhage is very great it can generally be controlled with perchloride of iron. If it is impossible, the cord must be left hanging out of the abdominal incision, and a drainage-tube passed into the cavity to keep it dry. It may be necessary to syringe out the cavity with some antiseptic, and in the event of any large portion of the placenta sloughing, to enlarge the opening to facilitate its removal.

Extraction through the vagina may possess certain advantages over the abdominal operation, if the fœtus can be felt presenting by the head or feet, and if the thinness of the structures separating the presenting part from the vaginal canal renders it certain that the placenta is not situated in that part of the sac.

In cases in which the fœtus is already dead no rules can be laid down. We must be guided by the general principles which direct the treatment of all abdominal tumours. If it is suppurating, an attempt must be made to open the abscess, evacuate the contents and drain the cavity with as little delay as possible.

Tumours of the Ovary and Broad Ligament

Tumours of the ovary may be divided broadly into two classes, cystic and solid.

Solid tumours are represented by fibroma or fibromyoma, sarcoma and carcinoma.

1. *Fibroma or fibromyoma* of the ovary is not very common, and is indistinguishable from fibroma of the uterus. Its growth is usually slow, but it sometimes attains a large size. Both organs are frequently affected at the same time. The tumours are hard, smooth externally, and on section present a perfectly homogeneous appearance. Under the microscope they are found to consist of fibrous tissue with a variable amount of non-striated muscular fibre.

2. *Sarcoma* is more frequently met with. It occurs as a primary affection and is often symmetrical. It grows with great rapidity, and is generally attended with ascites. Both the sarcomata and fibromata, occurring as they do in the free portion of the ovary, are generally pedunculated.

3. *Carcinoma* is almost invariably secondary to cystic disease of a non-malignant type. In all its forms it grows rapidly, and tends to invade the neighbouring organs, which soon become matted together in an immovable and indistinguishable mass. Pain and ascites are invariably present, and the general condition of the patient fails very rapidly.

Cystic tumours occur with much greater frequency than the preceding. They present an infinite number of varieties, which may be grouped under three heads: ‘multilocular,’ ‘dermoid,’ and ‘papillary.’

1. *Multilocular tumours* have their origin in the Graäfian follicles situated in the outer or free portion of the ovary—the oöphoron. On cutting into such a tumour, a mass of thin, but opaque-walled, secondary cysts, mixed with more or less solid growth, is seen projecting into the main

cavity, and from the cysts when opened there escapes a glairy mucoid fluid, in some cases as tenacious as treacle.

The small cysts are lined with columnar epithelium of large size. In the larger ones it is more flattened or tesselated, in many parts dipping down to form mucous glands.

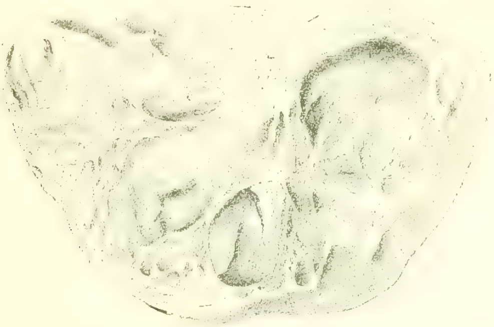

FIG. 472.—Multilocular ovarian cyst.

The more solid portions consist of young or embryonic connective tissue, crowded with spaces filled with mucus. These secondary cysts are indistinguishable from the retention cysts formed in mucous membranes, and, indeed, the solid masses are really adenomata on the type of mucous glands.

One cyst often predominates to such an extent that the tumour appears to be unilocular, but examination seldom fails to reveal secondary cysts projecting under the lining membrane, generally towards the site of attachment of the pedicle.

As multilocular cysts originate in the free part of the ovary, the paroöphoron or tissue of the hilum, as it is termed, remains unaffected, and such tumours are invariably pedunculated.

The Graäfian follicles are liable to other degenerative changes than those just described. In some instances they undergo simple dropsical distension, the cysts thus formed varying in size from a cherry to that of the fœtal head. The walls are thin, membranous, and translucent, identical in structure with those of the follicle. The contents are a clear, limpid fluid, with an ovum sometimes floating freely, sometimes attached to the epithelial lining, which is smooth and without projecting septa. Rokitansky first described this condition.

FIG. 473.—Dermoid cyst of the ovary, showing hair, teeth, and nipple.

2. *Dermoid cysts* of the ovary, according to Sutton, are simply a highly

organised form of the common multilocular, glandular cyst, and like it have their origin in the Graäfian follicles.

The walls of a dermoid cyst resemble in every respect true skin. The inner surface is lined with thick layers of squamous cells, becoming more rounded in the deeper strata. Beneath this is a layer corresponding to the cutis, and frequently presenting papillæ: deeper still are areolar tissue and fat containing hair-follicles, sebaceous and sweat glands. Teeth, either perfect or rudimentary, are often present in large numbers, springing either from the cyst-wall or from well-formed alveoli in bony plates. Sometimes even a mammary gland is found, presenting a nipple and capable of secreting a fluid. The contents of the cyst consist, in many instances, of a bright yellow liquid, composed of fat, cast-off epithelium, and cholesterin. At the temperature of the body it remains liquid, but very soon solidifies on cooling. In other cases the contents are of much the same colour and appearance as gruel or putty. Mixed with this are often large masses of loose hair, generally of a pale colour, and loose teeth.

At first sight nothing can present a greater contrast than a dermoid and a multilocular, glandular tumour. They, however, both take their origin in the same part of the ovary—the oöphoron—and they are frequently found associated. Careful examination of a multilocular tumour often discloses a small patch of dermoid tissue, and the presence of a few hairs. The great frequency with which dermoid tumours occur in the ovary would seem to prove a close connection with the production of Graäfian follicles; and if the membrana granulosa of the follicle is capable of forming mucous membrane and complex mucous glands, there is no reason why it should not form skin, which is practically identical with mucous membrane and its accompanying teeth and hair. All these transitional stages have been traced by Sutton.

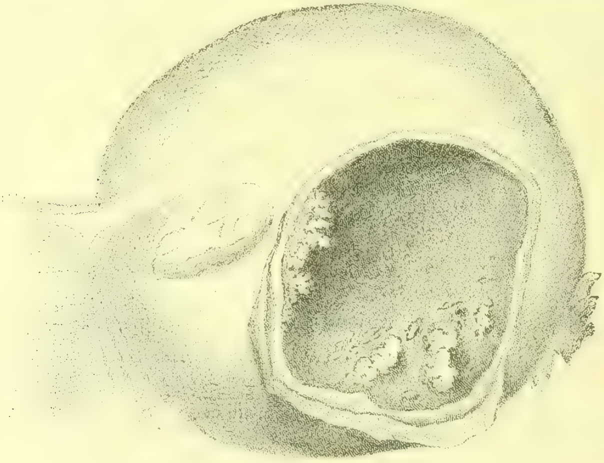

FIG. 474.—Papillary cyst of the ovary.

3. *Papillary cysts* of the ovary have a totally different origin, and arise in the paroöphoron or tissue of the hilum. Multilocular tumours, arising in the free part of the ovary, are usually pedunculated; papillary cysts, on the other hand, arising in the hilum, are more usually sessile and tend to burrow between the layers of the broad ligament, while the ovary more or less retains its shape or is flattened out upon the surface of the cyst.

The paroöphoron or tissue of the hilum is composed largely of fœtal elements. The vertical tubes of the parovarium converge towards its attached border, and can be traced through its substance sometimes even into the oöphoron. These tubes, in the perfect condition, are lined with ciliated epithelium. They have a tendency to morbid changes and to become cystic, the chief peculiarity of the cysts being the development of solid papillary or cauliflower growths from their inner surface. These growths are covered on the free surface with a layer of cylindrical epithelium, occasionally ciliated and bleeding readily when handled during operation. They have a tendency to burst through their cyst-walls and then spread over and infect the neighbouring organs. The secondary deposits often exhibit the same character, and the pelvis has been found filled with masses of thin-walled cysts studded with numbers of outgrowths. Cysts of this kind invariably contain a thin fluid, quite different to the mucous contents of the multilocular tumours, and often stained with blood.

The occurrence of mixed multilocular and papillary tumours is readily explained by the fact that the fœtal elements are often found extending into the oöphoron.

The papillary growths have a further tendency to become malignant in character, but under what conditions is uncertain. The removal of a papillary tumour which has already infected the neighbouring peritoneum has been followed by permanent cure, and the secondary growths have been ascertained by subsequent operation to have completely disappeared.

Cysts of the broad ligament are either ‘ simple ’ or ‘ papillary.’

Simple cysts may take their origin in any part of the broad ligament, and when of minute size are sometimes present in considerable numbers. Occasionally they are pedunculated, but more frequently they stand out from the surface without possessing a distinct pedicle. They are invariably unilocular, with thin walls lined with flattened epithelium, and contain a clear limpid fluid, with but little albumin. Their growth is very gradual, and they cause but slight peritoneal irritation, so that adhesions are rarely present. When pedunculated they cannot be distinguished from thin-walled ovarian cysts. When sessile, the tumour usually causes great lateral displacement of the uterus.

Papillary cysts are developed from the vertical tubes of the parovarium, and are identical in every respect with those formed from similar structures in the hilum of the ovary. They may increase in size with great rapidity, and should rupture occur, the papillary masses have the same tendency to sprout into the peritoneal cavity, and extend over the surface of the uterus and neighbouring organs. Compared with the simple variety, these latter are not of very common occurrence. Papillary cysts are always sessile, and cannot, even when of large size, acquire a central position in the abdomen, like an ovarian cystoma. *Per vaginam*, the uterus is always found displaced to one side, and the sense of immobility is very plainly marked, but a certain diagnosis is impossible.

Symptoms. 1. *The early stages while the tumour still occupies the pelvis.*—The symptoms in many cases are so slight that they escape notice altogether ; in others there is a history of long-continued pelvic trouble and pain in the ovarian region. Menstruation is not necessarily affected, but as the disease advances there is a tendency for it to become more and more scanty. Conception may occur, even though both ovaries are more or less cystic. If the tumour falls into Douglas' pouch, it may give rise to symptoms of pressure upon neighbouring organs.

On bi-manual examination, a smooth, rounded, tense body can be felt, stretching the roof of the vagina on one side of the cervix, or a little behind. If there is a distinct groove or furrow between it and the uterus, and if it is movable, so that it can be easily lifted out of the pelvis, it is tolerably certain to be a small cyst of the ovary. The chief difficulty in diagnosis occurs in connection with dropsy of the Fallopian tube. The latter condition may usually be distinguished by the fact that it is in many cases symmetrical, and by the history, for it is usually preceded by prolonged pelvic trouble. Sometimes a small cyst suppurates (a frequent complication with dermoid tumours), and forms a swelling that, on vaginal examination, is painful, tense, fluctuating, and indistinguishable from a pelvic abscess.

2. *After the early stage is past, when the tumour rises up into the abdomen.*—(1) *Obesity* may give rise to the suspicion of ovarian tumour, especially if it is associated with loss of tone in the intestinal wall, so that the abdomen becomes immensely distended with flatus and fæces. The indications of general obesity ; the soft flaccid condition of the abdominal wall when the patient lies down ; the absence of any tumour on palpation ; and the sinking of the two recti below the general level, when the patient endeavours to raise herself, are sufficient to dispel any doubt.

(2) *Pregnancy, when the uterus has begun to rise out of the pelvis.*—Ordinarily speaking, the diagnosis can be made at once from the mammary changes, the placental bruit, fœtal cardiac sounds, fœtal movements, ballottement, softening of the cervix, blueness of the vagina, &c. ; but, in exceptional cases, there may be some difficulty. The two, for example, may occur together. This may be suspected when, with a history of pregnancy, vaginal examination shows the uterus to be elevated, with the cervix high above the pubic symphysis, and an obscurely fluctuating mass lying behind it; or when the abdominal distension is greater than the period of gestation would account for. At a later period, the abdomen may be distended laterally and asymmetrically, with a sulcus separating the two tumours.

(3) *Hydramnios.*— This may easily be mistaken, as the distension is out of all proportion to the period of pregnancy ; and the walls of the uterus are so thin that fluctuation can be felt, just as in an ovarian cyst. The cervix, however, is soft as in pregnancy, and it is spread over and evidently continuous with the tumour. The sound may be used to decide the question.

(4) *Abdominal pregnancy.*—The symptoms of pregnancy are present, but the position of the tumour corresponds more nearly with that of an ovarian cyst. If the outline of the child can be felt, or its movements seen, while the uterus remains soft and empty, there is no difficulty ; but, in old-standing cases, unless the history is very clear, a positive diagnosis may be out of the question.

(5) *Ascites, especially with thin-walled unilocular cysts.*—The most important diagnostic sign is the relative position of the intestines and the tumour. In ascites there is resonance in front and dulness in the flanks; and this varies with the position of the patient ; again, in the recumbent position, the flanks bulge out and the belly becomes flatter. In ovarian disease this is reversed. In the erect position, the upper limit of the area of dulness is concave in ascites, convex if there is an ovarian tumour.

OVARIAN CYST *v.*	ASCITES
History	
General health good before discovery of enlargement, failing gradually since.	Health fails before the swelling appeared.
Often dysmenorrhœa.	Nothing characteristic.
No organic disease.	Disease of heart, liver, kidneys, or peritoneum.
Tumour, lateral at first, central later.	Bulging at lower part of abdomen when standing.
Œdema of extremities late.	Œdema early.
Inspection	
Abdomen prominent, often irregular. Umbilicus never prominent or thinned.	Abdomen flat in front, bulging at the sides and evenly. Umbilicus often prominent and thinned.
Greatest circumference below umbilicus.	Greatest at umbilicus.
Facies ovariana not marked until late.	Often cachectic from the first.
Palpation	
Abdominal wall tense, and resists pressure.	Soft and lax, unless amount of fluid very great.
Fluctuation most distinct superficially in front.	Most distinct in flanks.
Aortic pulsation may be felt.	Never transmitted to the front.
Per vaginam, the cyst may be felt at the roof or in the cavity of the pelvis, partially displacing the uterus.	No cyst, a sense of bulging only.
Percussion	
Dulness in front: flanks resonant.	Resonant in front, flanks dull.
In erect position, line of dulness convex.	In erect position, concave.
Dulness not altered by change of position.	Varies according to position.
Character of Fluid	
Fluid viscid, sticky, sp. gr. 1018—1024.	Limpid, sp. gr. 1010—1015.
Varies in colour.	Light straw-yellow.

Difficulties may arise from :—

(*a*) The absence of mesocolon, so that the flanks are resonant.

(*b*) The small intestine being tied down by adhesions, so that the front of the abdomen is dull.

(*c*) The fluid being encysted, as in old tubercular peritonitis.

(*d*) Carcinoma of the peritoneum, but usually rough nodules can be felt.

(*e*) Both may be present: and then the cyst may be felt sometimes by suddenly depressing the front wall with the fingers.

(6) *Hydatids of the liver or omentum*—The enlargement usually takes place from above. The pelvis is free; the uterus and ovaries normal; and there is a line of resonance between the tumour and the pubes. If the aspirator is used, the fluid is colourless, of low specific gravity, with no albumin, but some chloride of sodium.

(7) *Hydronephrosis.*—There is no difficulty when the tumour is small or varies in size concurrently with the passage of large quantities of urine. As the tumour enlarges and grows towards the centre and down into the pelvis, the diagnosis may be almost impossible. The relation of the intestine to the tumour (the colon lying on it, either as a band which rolls under the finger, or as a line of resonance, according to the distension), and the dulness reaching round in the flank quite to the spine, are the most important diagnostic points.

(8) *Uterine tumours and fibrocysts.*—These may usually be distinguished by the slowness of their growth, by their solidity, and by the fact that, apart from menorrhagia, they do not impair the general health. The pelvis is more or less filled up by the uterine growth; the cervix is drawn up behind the symphysis, or otherwise displaced; bi-manual examination shows that it is continuous with the tumour; the length of the uterine cavity measured by the sound is greatly increased; and abdominal movement of the tumour is distinctly communicated to the sound *in utero*.

OVARIAN CYSTIC DISEASE *v.*	UTERINE FIBROCYSTIC DISEASE
May occur at any age.	Rare before thirty.
General health suffers soon.	Good, unless there is menorrhagia.
Emaciation.	None.
Complexion pale, face pinched, 'facies ovariana.'	Often florid, at other times the face is dull, dejected, and muddy.
Tumour, lateral at first.	Tumour generally central.
Growth rapid.	Slow.
Surface uniform, fluctuation distinct.	Often lobulated; elastic, but fluctuation obscure. Cyst-wall thick.
Uterine souffle never heard.	Often present, resembling the placental bruit.
Uterus not enlarged.	Elongated, and canal tortuous.
Tumours may be raised from the pelvis, or uterus can be moved independently of the tumour.	Tumour continuous with uterus, and moves with it.
Fluid viscid, albuminous, clear or dark, not spontaneously coagulable.	Fluid clear and limpid, not viscid; little albumin; yellow or muddy; coagulates spontaneously.
Menstruation not necessarily affected: may be dysmenorrhœa at first, and then suppression, but no menorrhagia.	Profuse menorrhagia, unless tumour is subperitoneal.

In spite of these differences it may be impossible (without an exploratory incision) to distinguish an ovarian cyst from a soft, rapidly-growing myoma, or from a fibrocyst connected with the uterus by a slender pedicle. A dermoid closely connected with the uterus much resembles a fibroid.

Complications. *Adhesions.*—Adhesions are found not to interfere with recovery unless they are so extensive as to prevent removal. Their absence may be presumed if there has been no peritonitis, and if the tumour and the uterus are both freely movable. Extensive adhesions, however, may connect it to the liver above, the intestines behind, and the pelvis below, without its being possible to determine beforehand their extent or even their presence.

Rupture of the cyst.—In the majority of instances this is mere leakage, and the fluid is absorbed at once with but slight discomfort. Traumatic rupture, however, may be followed by fatal hæmorrhage or peritonitis.

It may be caused by simple thinning; or by degeneration from thrombosis; or by the formation of secondary cysts in the substance of the main wall, weakening it as they enlarge until it gives way.

When the leakage is slow, there may be no symptoms of peritoneal irritation at all. The tumour, if the loss is of any amount, diminishes in size; its tension falls; and the solid parts become more prominent. At the same time signs of fluid in the peritoneal cavity make their appearance, but there may be nothing to call attention to the accident.

When, on the other hand, the rupture is sudden and due to injury, there is the most intense shock, with, if the patient rallies, great danger from hæmorrhage and, later, peritonitis.

Immediate operation is the only course. The peritoneal cavity may be filled with the glairy, colloid contents of the cyst, or with blood-clot. In either case this must be turned out, the pedicle secured, and the tumour removed in the usual way. The peritoneum must then be thoroughly cleansed with a stream of warm water. In the case of colloid cysts a certain amount of peritoneal irritation is generally present; when bathed for a long time in the colloid fluid the membrane becomes thickened and injected, presenting an appearance like that of boiled sago. The removal of this material is a matter of great difficulty, as it clings with great tenacity to the intestines and abdominal organs; the most effectual method is repeated flushing with warm water, in which it is partly soluble.

Twisting of the pedicle.—This is probably due to the tumour being pressed upon by the viscera above and the pelvic structures below, while it remains free laterally and anteriorly; each time the patient, lying on her back, rolls over on her side, it rotates a little, and if it does not return, or if there is any irregularity of shape assisting it, it may at last be carried too far to recover itself. An accumulation of fæces in the rectum can impart considerable rotation to the pelvic tumour.

If the twisting is complete the symptoms are very characteristic. Pain, vomiting, and shock come on with great severity; the tumour rapidly increases in size; peritonitis sets in, though without any great rise in temperature, and the patient's condition becomes very alarming. If, on the other hand, it is only partial, the symptoms are less sudden but equally severe. More or less complete strangulation occurs, with intense venous congestion, hæmorrhage into the cyst, and, later, peritonitis. Gangrene is rare, owing to the rapidity with which vascular adhesions develop and maintain the circulation. Sometimes the pedicle disappears and the growth of the tumour depends on the new attachments formed in this way; exceptionally the tumour itself atrophies.

Ovariotomy should be performed as soon as the shock has subsided. The cyst is generally found intensely black and filled with clotted blood, and the peritoneum everywhere covered with lymph and soft adhesions. If the loss of blood is not excessive, the prognosis is not unfavourable.

Treatment. *Tapping.*—This can only be recommended for cases in which immediate relief is absolutely necessary and the condition of the patient too serious to admit of complete removal. It has been followed by hæmorrhage, peritonitis, and by suppuration in the cyst, and is a proceeding to be avoided if possible. For purposes of diagnosis it is of little use.

Ovariotomy.—The time selected should be shortly after a menstrual period. An aperient is given the day before, and an enema the morning of the operation, to ensure that the bowels are fully relieved; and a catheter should be passed if there is any question as to the condition of the bladder. The extremities should be warmly clad, the shoulders slightly raised, and the abdomen protected with a waterproof sheet in which there is a central opening large enough to expose the skin from the pubes to a short distance above the umbilicus. The margin of this is covered on its under surface with adhesive plaster, to prevent any fluid escaping beneath.

The assistant stands on the patient's left, opposite the operator. A nurse is required, whose sole duty it shall be to attend to the sponges. All instruments, ligatures, &c., are to be kept immersed in a five per cent. solution of carbolic acid; and, like the sponges, they must all be counted, in order that none may accidentally be left in the abdominal cavity.

Special instruments required are: twelve small pressure-forceps; two cyst-trocars, large and small, either Wells' or Tait's, with tubing; four large cyst-forceps, angular and straight; two pedicle-needles, in handles, blunt; and six sponge-holders. Six of Keith's glass drainage-tubes of various sizes should be at hand.

The incision is from two to three inches in length according to the thickness of the abdominal walls, midway between the umbilicus and the pubes; and planned to hit off the division between the recti. As soon as the peritoneum is exposed, it is picked up with a pair of forceps and carefully opened. Unless adhesions are present, the bowels fall away as the air is admitted, so that there is no danger of their being wounded. Considerable difficulty, however, may be experienced if the peritoneum is thickened and vascular from old attacks of inflammation, or adherent to the front of the tumour; the sub-peritoneal areolar tissue may be mistaken for intraperitoneal adhesions, and the serous membrane stripped away from the transversalis fascia. If there is the least doubt, it is always advisable to prolong the incision upwards, until a space that is certainly free from adhesions is reached.

If the length is not sufficient the incision may be extended downwards to the pubes (care being taken not to wound the bladder) or upwards, towards or even beyond the umbilicus, passing either through it or round to the left side.

As soon as the tumour is exposed and its general character and relation ascertained, the size should be reduced as far as possible by emptying it of its contents. Simple cysts may be tapped at once, the trocar being driven smartly in while the tumour is steadied and pressed somewhat forwards by the assistant, so that none of the fluid enters the abdominal cavity. Multiple cysts may be treated in the same manner, the trocar, without being withdrawn, being driven through one to the other until all the larger cysts are emptied. If the contents are too viscid to flow through the cannula, it should be withdrawn, the opening enlarged, the septa thoroughly broken down, and the débris scooped out with one hand while the walls are drawn forwards by means of forceps with the other, the assistant meanwhile keeping up steady pressure upon the sides of the abdomen, and preventing the escape of the intestines by the side of the tumour.

As the cyst diminishes in size and is gradually drawn out through the abdominal opening, any adhesions that may be present come into view. Recent ones may be easily separated by the pressure of a sponge; older ones are better secured with a ligature. For obvious reasons it is not advisable to leave forceps attached inside the abdominal cavity. If the cyst is so firmly attached to the bowel that it cannot be separated, the adherent portion of the wall should be cut off and left *in situ*. Sessile tumours burrowing between the layers of the broad ligament must be enucleated. Commencing near the uterus, the peritoneal investment is carefully stripped off the tumour, keeping as close to the cyst wall as possible. The flaps of the broad ligament are then sewn together, or ligatured, or, if the cavity be very deep, sewn to the abdominal incision and a drainage-tube inserted.

The pedicle is secured with a silk ligature, and returned into the abdominal cavity. If it is too large to be embraced in one loop, it may be transfixed and tied in two halves with a figure-of-eight ligature; or Lawson Tait's Staffordshire knot may be employed. An ordinary handled needle, threaded with a long piece of silk, is passed through the pedicle and withdrawn, leaving a loop on the distal side. This is drawn over the tumour, and one of the free ends passed through it, so that one is above and the other below the loop. The pedicle is then fixed with the finger and thumb of the left hand, and the two ends of the ligature drawn as tightly as possible, and secured by means of an ordinary knot. The thinnest portion of the pedicle should always be selected, and if it is very bulky it may be reduced in size beforehand, by clamping it temporarily with a pair of strong forceps. If there is the least doubt as to its being properly secured, a pair of catch-forceps should be fastened to it, so that it may be drawn up and inspected the last thing before the wound is closed.

Finally, the other ovary should be examined, taking care not to make too much traction upon the uterus for fear of disturbing the ligature already applied.

The abdominal cavity should be thoroughly cleansed from all clots and foreign material, warm dry sponges being carried down into the loins and Douglas' pouch for the purpose. If any of the contents of the cyst have escaped, thorough irrigation with hot water is preferable; it is more efficient and does less harm. Drainage should be adopted in cases of enucleation, and where, owing to the depth in the pelvis or extent of the adhesions, it is difficult to see and control the hæmorrhage. The tube should be sufficiently long to reach to the bottom of Douglas' pouch without pressing upon the rectum. There is a small collar at the upper extremity, which rests upon the edges of the wound at the lower angle, and it is perforated at the sides with several small openings, so that fluid may find its way in, and be removed as required by means of a syringe.

A flat sponge is placed upon the surface of the intestines, while the sutures are being passed. Silk or silkworm-gut is the best material for the purpose; all the layers of the wall must be transfixed; and the sutures placed sufficiently close to ensure thorough adaptation of the peritoneal surfaces.

The sponge is withdrawn when they are all in position and tied, except the last one or two. Absorbent dressings are laid over the wound of sufficient thickness to fill up all the natural hollows of the abdomen ; and, if a drainage-tube is used, to protect it from pressure ; and over all a many-tailed bandage is applied. Then the patient is carefully lifted up from the table to a well warmed bed placed by its side.

The thin wall of a broad ligament cyst presents a characteristic appearance, differing greatly from the shining, opaque, and silvery-white surface of an ovarian cystoma. When pedunculated it can easily be secured with a ligature. The Fallopian tube and ovary are frequently flattened out over the cyst, and need not necessarily be removed with the tumour ; but it is better to remove them than to complicate the operation by attempting to separate them. When sessile the cyst burrows deeply between the layers of the broad ligament. In such cases it is necessary to reflect the peritoneum from the surface of the cyst and carefully enucleate it. Care must be taken not to injure the uterine artery, which forms a loop with its concavity upwards close to the neck of the uterus, and the ureter, which runs across beneath the base of the broad ligament to its insertion in the bladder. The flaps of the broad ligament may be united by sutures or treated as a pedicle and partly cut away, according to circumstances.

After-treatment.—For the first twenty-four hours it is better to give nothing but small quantities of hot water or hot toast-water. The second day the patient may take a little arrowroot or beef-tea. An irritable condition of the stomach is frequently a troublesome complication. Drugs are of little use. If the retching is severe, a tumblerful of warm water will often help the patient to bring up a large quantity of mucus, and relieve the symptoms. Should it fail, the administration of all nourishment by the mouth must be discontinued, and the patient supported by nutrient enemata. In the case of feeble subjects this may be done at once with advantage. Peptonised beef-tea is the best when it can be procured : three ounces should be injected into the rectum about every four hours. Before giving an enema the rectal tube must be passed two or three inches into the rectum, and allowed to remain there for a few minutes, to permit the escape of flatus and any fæcal matter which may be present.

The administration of an opiate after the operation is not necessary unless there is pain. Many patients are very intolerant of the drug. It is especially deleterious in those cases in which the urine is scanty, slightly albuminous, and of low specific gravity. When required, it may be given in the beef-tea enemata.

If the bowels have not acted spontaneously, measures should be taken to procure an evacuation by the evening of the fifth day. An enema of four ounces of warm olive oil may be injected, and, four hours later, a pint and a half of soap and water. As a rule an action speedily follows ; if not, the enema must be repeated. A gentle purgative does no harm ; on the contrary, when the appetite is lost and the tongue thickly furred, it is certainly beneficial. A drachm of compound liquorice powder or some other laxative may be given with the preliminary olive oil enema.

The catheter need not be passed until the patient asks to be relieved. Afterwards it will be required three times daily for the next two or three days, but the use of the instrument should be discontinued as soon as possible. The majority of patients can pass their urine voluntarily after the first forty-eight hours, but in some cases the want of power continues for several days.

A water-bed is advisable, especially for aged patients. Every care, in such cases, must be taken to avoid the occurrence of a bed-sore ; the patient must not be strictly confined to her back, but be allowed to change her position from time to time and lie on her side. The catheter should be avoided altogether, if possible.

The dressings need not be touched until the eighth day. By that time the wound should be united and the sutures may be removed. The wound should then be washed, carefully dressed with carbolic gauze, and supported with strapping. The patient must not be allowed to get up under a fortnight, and meantime should be provided with a well-fitting abdominal belt. It must not be forgotten that the cicatrix may stretch and form a hernial sac into which a large mass of intestines and omentum may obtrude itself, to the great discomfort of the patient. To obviate this it is necessary to protect the cicatrix carefully long after convalescence.

Complications. *Shock.*—The shock may be severe, especially if the operation is prolonged. Warm blankets, hot-water bottles, &c., must be used freely to keep up the temperature, and a little brandy or ether and sal volatile may be given as soon as the patient can swallow.

Rise of temperature.—In about twenty-four or thirty-six hours after the operation the temperature usually reaches its highest point. In many cases this is not above 100°, but a considerable rise of temperature at this time is not of any serious import. If it rises above 102° with a concomitant rise of pulse, the application of the ice-cap will reduce it.

Secondary hæmorrhage may arise from the pedicle slipping out of the ligature. It is very important, when securing it, not to exercise too much traction on the pedicle ; the outer border is liable to retract and slip out, and the ovarian artery thus set free bleeds freely. If there is any fear of this, the ovarian vessels in the outer border should be secured separately. The splitting of the pedicle may also be a cause of secondary hæmorrhage ; this is liable to occur if it is transfixed and tied without the threads having been properly crossed, the two halves of the pedicle being pulled asunder. Secondary hæmorrhage may also occur from vessels in adhesions.

The symptoms of internal hæmorrhage are characteristic and usually come on within a few hours after the operation. The patient becomes faint and blanched, and the pulse small and rapid. There must be no hesitation : the only course open is to place the patient under an anæsthetic, re-open the wound, and find and secure the bleeding point.

Peritonitis and septicæmia may come on from the second to the fourth day. The earlier symptoms are very insidious, but the following combination is sufficiently grave. The vomiting which most patients suffer from for a few hours, and is probably due to the anæsthetic, instead of subsiding, persists. At first it is white and frothy, but subsequently green or dark ; the pulse increases in frequency, at the same time decreasing in force ; the respirations are more frequent ; the face becomes pallid or slightly jaundiced, the mental condition depressed ; the tongue is red, rough, and dry, though, like the skin, it sometimes remains moist throughout ; the abdomen becomes tympanitic and tender, and no flatus is passed. The temperature in many cases continues low from the first, and does not afford any characteristic indication.

The **prognosis** is most unfavourable. When the symptoms are those of general peritonitis, active treatment is of little avail. When they point to the formation of an abscess in the pelvis, or in the abdominal walls around the wound, there is more hope.

The stomach may be washed out with warm water every six or twelve hours, if the vomit be dark and bilious, until it ceases. The passage of the rectum tube may enable the flatus to escape and relieve somewhat the abdominal distension. Beef-tea enemata must be administered every three or four hours.

Intestinal obstruction is a complication that occasionally follows ovariotomy. It may be caused in various ways—by the intestine becoming adherent to the abdominal incision or other raw surface, or by its becoming entangled in the omentum. Should the complication occur during the first or second week following the operation, its symptoms are very liable to be mistaken for those of peritonitis or septicæmia. If the condition is recognised, the abdominal wound should be reopened and the obstruction removed.

Phlegmasia may occur, especially during convalescence ; and cases have proved fatal from portions of the clot becoming detached.

Tetanus also has been known to occur.

TUMOURS OF THE UTERUS

Tumours of the uterus may be malignant or non-malignant. The former include sarcoma and carcinoma ; the latter, fibromyoma, fibroma and fibrocysts.

1. *Non-malignant Tumours* (‘ *Fibroids* ’)

These resemble in their structure the tissues that normally form the wall of the uterus, but the proportions in which they occur differ very considerably. Some are soft, pale or flesh-coloured, rapid in growth, and ill-defined in outline, consisting almost entirely of unstriped muscular fibre—‘ *myoma*.’ Others grow very slowly, present a white and glistening surface on section, and are almost as hard as cartilage. These consist of nothing but fibrous tissue—‘ *fibroma* ’—arranged concentrically layer upon layer. Unlike the former, they are almost non-vascular, and are surrounded by a capsule of loose connective tissue, which differentiates them from the surrounding uterine wall. In this loose fibrous tissue run the blood-vessels which supply the tumour.

Fibroids occur with the greatest frequency during middle life, between the ages of thirty and forty-five. It is uncertain whether they ever originate after the climacteric; but they may continue to grow, and in some instances very rapidly, after that epoch. Sometimes they remain unchanged for years. During menstruation and in pregnancy they frequently increase very fast ; subsequently they undergo involution with the rest of the uterus, and may disappear completely.

Fibroid growths are liable to degenerative changes of various kinds. Occasionally the central portions become changed into mucous tissue, and the soft semi-fluctuating tumour thus formed may readily be mistaken for a cystic tumour of the ovary. Sometimes cavities or cysts form in them, containing pus, blood, or serum. Such cysts may attain an enormous size, and, like the preceding, simulate ovarian disease very closely. After the menopause, fibroids generally cease growing, but exceptions to this are not uncommon. They may atrophy and disappear ; or they may undergo calcareous degeneration, the outer layers especially being affected, so that sometimes they appear to be surrounded by a kind of shell. Sarcomatous and carcinomatous changes are supposed by some to occur in them, but it is open to question whether the occurrence of the two conditions in the same uterus is not a mere coincidence.

There is no limit to their number. They may occur in the cervix, but are much more common in the body of the uterus. Sometimes they grow in the centre of the uterine wall (*interstitial fibroids*); sometimes they develop on the surface, either the internal (*submucous*) or the external (*subperitoneal*). In this case they may either remain sessile or become pedunculated and project as polypi into the cavity of the uterus or that of the peritoneum. A submucous fibroid may be gradually separated from the uterus by an elongating pedicle and expelled by the uterine contractions into the vagina. Subperitoneal fibroids are also occasionally entirely detached from the uterine surface. When connected by a long pedicle these tumours are very liable to give rise to serious complications, from their tendency to fall into the pelvis and become incarcerated, or by becoming accidentally twisted on themselves and strangulated.

Symptoms.—These depend to a great extent upon the situation of the growth. Sometimes they are entirely wanting, so that the tumours remain latent for the whole of life.

Hæmorrhage is the most characteristic, and is rarely absent except in the case of the subperitoneal variety. With large interstitial growths it is often profuse. Usually it takes the form of menorrhagia coming from the hypertrophied mucous membrane of the uterus, and beginning as an aggravation and prolongation of the menstrual flow. With submucous fibroids it may occur at any time, coming from the ulcerated and granulating surface of the tumour, and accompanied by a profuse leucorrhœal discharge. This latter can be distinguished from the discharge present in cancer of the uterus, by being less watery and free from fœtor.

Pain.—Discomfort, a sense of weight in the lower part of the pelvis, and bearing-down pains are generally present, and, owing to the increased size of the tumour, are always worse at the menstrual periods. The submucous and interstitial varieties are attended by characteristic uterine dysmenorrhœa, the tumours acting as a foreign body and exciting irregular contractions like the pains of labour. As a rule, this is not present in the subperitoneal form.

Pressure.—The urinary organs suffer the most frequently; an irritable condition of the bladder may be excited by the presence of even a small fibroid. Suppression may occur from compression of the ureters; incontinence from the bladder being dragged into the abdomen and the urethra stretched; or retention if the tumour presses the urethra against the pubes. Sometimes this is intermittent, owing to the varying size of the growth during the menstrual period.

In other cases the rectum is compressed so that constipation and even obstruction are caused; and, as the tumour grows in size, like large ovarian cysts, it very seriously interferes by its mere bulk with the working of the abdominal and even the thoracic viscera.

Sterility and abortion.—Pregnancy seldom occurs when there is a submucous or interstitial fibroid of any size. If it does, either the patient miscarries, or, if the full term is reached, there is a great danger of post-partum hæmorrhage, and of metritis and pyæmia due to sloughing of the tumour.

Physical signs.—These differ according to the locality.

1. *Submucous.*—If pedunculated and in the lower segment of the uterus, a fibroid can often be felt projecting through the cervix as a hard, smooth, rounded mass. It may be necessary to dilate the os before this can be done. By introducing the finger into the cavity of the uterus, the position and extent of its attachment can then be ascertained. If sessile, it may attain a large size, stretching the uterus like a capsule and reaching as high as the umbilicus.

2. *Interstitial.*—As with the former variety, the uterus is always increased in size. Its cavity, measured by the uterine sound, may be found to be six or eight inches in length. The canal is often rendered extremely tortuous by the tumours encroaching upon it, so that the passage of the sound may be very difficult or quite impossible. Small growths are difficult to detect. There is nothing but a peculiar lumpiness and sense of resistance in the walls of the uterus which the healthy organ does not present. A projecting growth may simulate a flexion of the uterus; but a careful bi-manual examination and the aid of the uterine sound will always obviate an error of this kind. When large, they rise up into the abdomen, occupying a central position, and form a solid, rounded, freely movable tumour, over which the uterine souffle can often be heard, especially at the sides. On vaginal examination the cervix is found displaced in various ways. It may be drawn up in the abdomen beyond the reach of the finger, or, if the lower part is involved, it may be altogether lost, the os appearing as a mere depression.

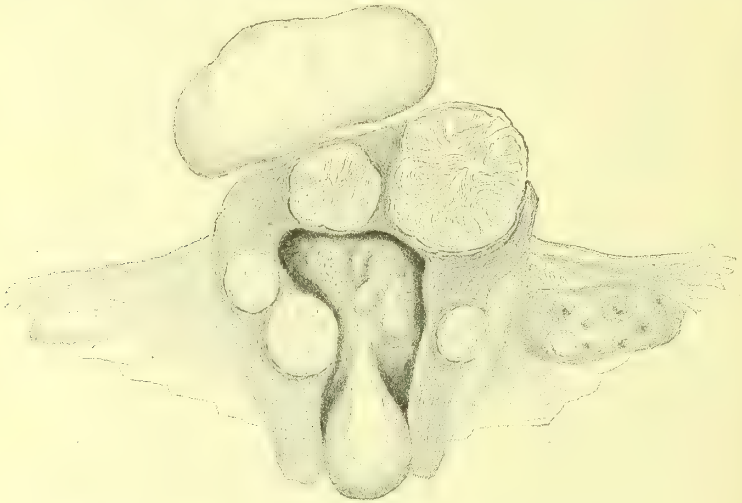

FIG. 475.—Uterine fibroids, subperitoneal, interstitial, and submucous.

3. *Subperitoneal.*—In these the uterine cavity is not necessarily enlarged, and the uterine souffle is not present. In addition to the general mobility of the tumour, the growths have a certain range of free movement, depending on the length of the pedicle. Palpation gives the idea of a number of hard rounded masses rolling one over the other. This characteristic, when present, is absolutely distinctive.

Differential diagnosis. *From pregnancy.*—When normal, pregnancy is easily distinguished; but a difficulty may arise if the fœtus is dead, and all the signs of pregnancy have disappeared, and there is a dark sanguineous discharge escaping from the enlarged uterus. This condition bears a close resemblance to the appearance presented by a partially detached submucous fibroid in process of expulsion. In extra-uterine gestation the history and the rapidity of the growth are sufficient.

Pregnancy coexisting with fibroid sometimes presents a difficulty: in addition to the ordinary signs, most reliance must be placed upon the want of uniformity in the shape of the uterus, and the size, which is larger than would correspond to the period of pregnancy.

From ovarian tumours.—In these the uterine souffle is never heard; the cavity of the uterus is not enlarged, and the tumour, as a rule, is soft and fluctuating. Manipulation of the mass in the abdomen does not move the sound in the uterus unless the connection between the latter and the tumour is very close. Fibrocysts, however, sometimes cannot be distinguished.

Abscess of the ovary or Fallopian tube, hæmatocele and inflammatory deposits occasionally present a difficulty, especially as inflammation is not unlikely to occur around a fibroid if it causes pressure.

Prognosis.—This depends upon the age of the patient, the nature of the tumour, the rapidity of the growth, the amount of hæmorrhage, and of pressure upon other organs. Sometimes fibroids cease growing or even disappear; and sometimes they are extruded and slough off, but these instances are exceptional. In many cases death results from hæmorrhage, exhaustion, suppuration, peritonitis, sloughing of the tumour, intestinal obstruction or secondary renal mischief; in many more the patient's health is thoroughly broken down, and some intercurrent disorder sets in.

Treatment. *Ergot.*—The hypodermic injection of ergot continued for many months is stated to have some influence in checking the growth of the tumour. Its action is very uncertain. The gluteal region is usually selected for the injection. The pain is extreme, and the punctures often suppurate. The practice has now been abandoned.

Electricity.—It is claimed that a constant current (commencing with 50 milli-ampères and increasing to 200 or 250) passed through the substance of the tumour at intervals of a few days will cause it to disappear, possibly by bringing into play those conditions which sometimes normally during life bring about the same result. One electrode, insulated to within two or three inches of the point, is inserted into the cavity of the uterus; the other (usually the positive) is applied to the surface of the abdomen. The latter should be of very large size (seventy to eighty square inches), and very well and evenly covered with a folded linen cloth previously damped in water, or with such currents the skin will be destroyed. Each sitting lasts five or ten minutes. Opinions are as yet divided as to the merits of this proceeding. In some cases there is no doubt the tumour has diminished or disappeared; in many it has been entirely unaffected; and in some, especially when high currents were used, sloughing and septicæmia followed. At present the method is entirely empirical.

Enucleation per vaginam.—If the vagina is healthy and spacious, and the os and cervix capable of easy dilatation, small tumours, more or less pedunculated, may be removed this way; and sometimes it succeeds with large interstitial fibroids, but only—and this is almost impossible to tell—when they are encapsuled.

The patient is placed in the lithotomy position, the cervix having been previously dilated, if necessary. The uterus is pulled down as far as possible by means of a vulsellum, and the attachment of the tumour carefully made out with the finger. If there is a distinct pedicle an écraseur may be placed round it at once, or it may be twisted off.

If, on the other hand, it is sessile, a deep incision is made through the mucous membrane and the capsule at the most convenient spot, and the substance of the tumour seized with strong vulsellum-forceps. Then, while an assistant pushes the fundus down from the abdomen into the pelvis, an attempt is made to insert the finger between the capsule and the growth, and shell it out. Emmet's nail-curette and Thomas's spoon-saw may be used with advantage, but all instruments add very greatly to the risk, especially as the fundus is approached, and great care must be taken in dragging upon the tumour not to invert the uterus, or its wall may be included in the écraseur and the peritoneal cavity laid open. The capsule is then washed out with iodine water and plugged with pledgets of cotton dipped in the same or some other antiseptic. These may be removed in forty-eight hours and the vagina washed out with a weak antiseptic night and morning until the discharge has ceased.

The operation is one of extreme difficulty. If any portion of the tumour is left it is certain to slough and very likely to cause septicæmia. The uterus does its best to extrude it, and sometimes a second operation may successfully complete the removal: but, except in those cases where the tumour is small or already presents at the os, the operation is not to be lightly undertaken.

Removal of the uterine appendages.—The object of this proceeding is to precipitate the menopause and so induce the condition of atrophy which may be expected to occur after that event. Sometimes it is performed with the view of checking hæmorrhage, sometimes with the view of arresting the growth of the tumour. The operation is commonly known as Hegar's. It is most feasible when the tumour is interstitial and of moderate size, the hæmorrhage periodic and excessive, and the normal menopause remote.

The patient is prepared as for ovariotomy. The abdominal incision is about three inches in length to begin with. The fore and middle fingers of one hand are slipped over the side of the uterus until the appendages are reached. The tube and ovary are drawn out of the wound, transfixed, ligatured, and divided. The appendages on the opposite side are then treated in a similar way. The operation is never to be recommended when the tumour has attained a large size. The appendages are often displaced by the irregular outgrowths; they may be behind or buried in the pelvis beneath the tumour and quite inaccessible. In some cases they are flattened out and adherent to the growth, from which it is impossible to separate them. Great care must be taken not to wound the surface of the tumour during the operation; hæmorrhage will ensue, which it is extremely difficult to check. In such case the operator must be prepared to proceed with the supravaginal amputation of the uterus.

The mortality is small, and in many cases a successful result is obtained: menorrhagia is checked and the tumour ceases to grow; in some it has completely disappeared. Should it fail, the condition of the patient is not in any way deteriorated, and in suitable cases resort may be had to the graver operation of supravaginal amputation.

Supravaginal hysterectomy.—This operation is advised when the tumour is large, especially if it is soft, growing rapidly, or attended with menorrhagia.

It is necessary in cases of fibrocyst, unless the tumour is pedunculated. The age of the patient need scarcely be taken into consideration; the menopause is indefinitely deferred, and it is useless waiting for it when a patient's life is threatened by a bleeding myoma. Its applicability is, however, limited to those cases in which sufficient of the cervix remains in a healthy condition to be utilised as a stump.

The instruments required are the same as those for ovariotomy, with the addition of Kœberlé's serre-nœud, a pair of pliers, two long pedicle-needles, and a Tait's screw. The latter resembles a large corkscrew, and is often of great service in the extraction of the tumour. A second serre-nœud should be in readiness.

The patient is prepared as for ovariotomy. An incision about four inches in length is made in the median line, care being taken not to injure the bladder, an accident which is far more likely to happen than in ovariotomy. The abdominal walls are usually very vascular, and all bleeding points must be secured with pressure-forceps. On exposing the tumours, the dark fleshy appearance of a uterine fibroid will at once be recognised.

The relations of the tumour to the broad ligaments are then explored, and if it appears capable of removal, the incision is enlarged to the necessary extent. A fibroid cannot be pulled out of the abdomen unless the incision be carried almost to the level of its upper border, especially if the tumour is broad. The incision may be carried through the umbilicus or to the left of that structure as far as required.

The presence of adhesions is then ascertained. These are most frequently omental, the vessels being sometimes enormously dilated. They must be secured by ligature, both on the proximal and distal side, and divided.

The tumour is now raised through the abdominal opening—not always an easy matter. It is slippery, possibly wedged in the pelvis, and a hand passed behind it fills up the abdominal opening to such an extent that it is impossible to lift it out without unduly enlarging the incision. The screw may then be thrust into the most prominent part, with its point directed towards the fundus. By depressing the handle and raising the point, at the same time drawing the tumour forwards, while with the other hand the abdominal wall is retracted over the fundus, it may be successfully coaxed out of its bed. The abdominal viscera are at once protected by a large warm flat sponge, which is pushed under the parietes. Any further adhesions are attended to, and the relation of the bladder to the front of the tumour ascertained, a sound being passed into the bladder, if necessary, for that purpose. It may be necessary to dissect it from the tumour.

The wire of a Kœberlé's serre-nœud is then passed around the tumour at the level of the os internum, including the tubes and ovaries and the greater part of the broad ligaments, which are pulled up by the assistant above the level of the wire. The loop is then tightened by means of the key, taking care that the bladder is not included.

No difficulty is experienced when the appendages lie evenly and high up on the sides of the tumour. If they are situated too low to be included with safety in the loop they must be removed separately.

When the tension on the broad ligament is excessive, it may be transfixed with a stout ligature close to the neck of the uterus and tied between the uterus and the ovary. The larger vessels being controlled by this, the peritoneal envelope of the uterus is freely divided at a distance of about three inches from the wire loop and reflected towards it. In this way the strain is relieved and a better pedicle can be obtained. The ovary is ligatured and removed separately.

If the tumour has extended laterally between the layers of the broad ligament on either side, enucleation is the only course. The torn ligament must be treated according to circumstances, any superfluous portion being cut away and the remainder secured by sutures or ligature.

The pins are then passed through the pedicle, parallel to each other, close to the wire on its distal side.

Sponges are packed round the pedicle, and the tumour cut away with a stout scalpel about two inches above the wire ligature. The uterine arteries are secured in the loop, but the blood in the tumour pours out in quantities as the incision is made. The assistant presses a sponge against the cut surface, and endeavours as far as possible to prevent the blood getting in the way of the operator. Immediately the tumour is cut away, the wire of the serre-nœud is again tightened, and the peritoneal cavity thoroughly cleansed.

The free edges of the peritoneal surface and the cut ends of the broad ligaments are secured at intervals with pressure-forceps. The stump is trimmed down until only sufficient tissue is left to prevent the pins from tearing out; then it is dusted with iodoform, and the edges stitched together over the face of the stump to make it as small as possible and to prevent the broad ligaments escaping as the tissues shrink. It is then secured in the lower angle of the abdominal incision. The parietal peritoneum is carefully applied to the peritoneal surface of the stump and secured by a suture; the rest of the wound is closed as in ovariotomy.

The stump is surrounded with absorbent dressings carefully packed under the pins and the whole secured with a many-tailed binder. The object is to keep it dry; if the dressings become moist they must be changed; but otherwise the wound may be left for several days. A small pedicle may dry up and become quite horny: if pus wells out by the side, in the course of a week the loop may be removed and stump dressed so as to facilitate the discharge as much as possible. Care must be taken not to allow it to slip back into the abdomen before it has begun to heal by granulation and is free from shreds and sloughs, as the wound forms a deep pit and healing is greatly retarded.

Pedunculated subperitoneal fibroids may require removal, owing to their size or to the presence of complications. If the pedicle is small, the uterus need not be interfered with; but if it is thick and short, or the growths are multiple, the entire organ must be removed. In either case the extraperitoneal method of dealing with the pedicle must be adopted. Even when it is small, transfixion and ligature are very unsafe. The muscular fibres contract; the cut surface begins to cup; and the ligature soon becomes loose. If it slips, the stump appears as a wide bleeding surface, but little if at all raised above the surrounding tissue. The operation is just as serious as removal of the whole uterus.

Hitherto the results obtained by the extraperitoneal treatment of the stump in hysterectomy have been so immensely superior to the intraperitoneal method that it has been almost universally accepted. It is obvious, however, as was the case in ovariotomy, that, if the results of the latter could be improved, it possesses many and great advantages over the extraperitoneal method. Recent experience tends to show that a change may be expected in this direction. The plan adopted has been to transfix the broad ligaments on either side with a double ligature. One is tied externally to the ovary and tube, the other, re-threaded on an empty needle, passed close to the neck of the uterus and tied, controls the uterine vessels. The tumour is then cut away, and the edges of the V-shaped incision carefully brought together so that the peritoneal surface shall be turned inwards. The stump is returned into the abdominal cavity and the wound closed. This treatment, which has met with considerable success, appears to be applicable to those cases in which the cervix is small and not involved in the growth.

2. *Malignant Disease of the Uterus*

The uterus is liable to be attacked by carcinoma and sarcoma; the former is much the more common.

Carcinoma most frequently occurs from forty to fifty years of age. Nothing is known as regards its etiology. Heredity is probably of little importance. It is slightly more common in women who have borne children than in others, but there is no proof that it is in any way connected with lacerations of the os, as has been affirmed.

It may begin in any part—the vaginal portion, the cervix, or the body, and varies in character according to the site. Carcinoma of the body is much the most rare (forming only two per cent. of the whole), and is usually met with rather later in life than the other varieties. Sarcoma always attacks the body.

1. *The vaginal part.*—This is rarely the seat of primary carcinoma, although it is often involved by extension from the cervix. It always takes the form of squamous epithelioma. At first the surface is smooth, shining and slightly livid; then the lips become enlarged, red, and granular. It spreads superficially rather than into the substance of the organ, and grows outwards on to the vaginal vault and the surface of the vaginal walls.

2. *The cervix.*—Carcinoma commences in the glands, especially at the lower part of the cervix, either superficially or deep, and follows the type of columnar epithelioma. It may assume the form of a polypus, hanging from one of the lips; or of a papillary growth on the surface; or a small nodule deep in the mucous membrane. Wherever it grows it tends to spread in the strata outside it and involve the periuterine connective tissue. Very often it grows downwards as well as outwards (extending under the vaginal mucous membrane), but it rarely transgresses the internal os.

3. *The body.*—This, like the former, commences in the glands and usually assumes the shape of nodules deep in the substance. Sometimes, however, it is superficial and spreads rapidly over the whole interior, making the surface rough and villous, and covering it with warty growths and polypoid masses. The cavity of the uterus is enlarged; the walls thickened; peritoneal adhesions form; the glands in the broad ligament become involved; and then those farther away along the internal iliac artery; but the growth rarely extends down to the cervix.

Symptoms.—At the commencement these are remarkably insidious and obscure.

1. *Hæmorrhage*—either with the menstrual flow or irregularly, after exertion or coitus. Owing to the vascularity of the growth this is rarely

absent. In older women, after menstruation has ceased, the recurrence of periodic hæmorrhage is of great significance.

2. *Pain*—at first and so long as the growth is confined to the cervix is generally slight. It is felt chiefly in the back and loins. Later it becomes more severe, especially at night, and is described as sharp and stabbing, or as burning or tearing. When the growth involves the peritoneum, or the sacral plexus, or the bladder, or rectum, it becomes intense and alters its character. Towards the end, fortunately, it very often diminishes.

3. *Discharge*—is very commonly present, watery and serous, or stained with blood at first, then becoming brownish from the débris mixed with it, and usually peculiarly offensive. After a time the health begins to fail; the patient becomes emaciated; œdema of the extremities is not uncommon, and the cachexia becomes evident.

Diagnosis must be made chiefly by the sense of touch. Hard nodules may be felt; the mucous membrane has lost its mobility; later an irregular ulcer is formed, with elevated, hardened borders which feel rough and friable and break down readily under the finger-nail. Sometimes the hæmorrhage following examination is profuse. The speculum is of little use; a certain degree of lividity can be made out in the early stages and later an irregular ulcerated surface. Rectal examination should never be omitted.

In carcinoma of the body of the uterus pain is an early and marked symptom; the cervix is normal or dilated; the uterus enlarged; hæmorrhage always follows the introduction of the sound. Introduction of the finger through the dilated cervix as a rule confirms the diagnosis at once.

Treatment.—When the disease is confined to the vaginal portion, the cervix may be removed. When the canal is involved the extent of the disease must determine the necessity for partial or complete hysterectomy. Cancer involving the body can be treated only by complete extirpation.

Amputation of the cervix.—This may be performed in various ways: with the galvano-cautery, the écraseur, or the knife and scissors.

The patient is placed either in the semiprone or lithotomy position. The cervix is exposed by means of a Sims' speculum, and drawn down with a vulsellum to the vulva. The wire is passed over the handle and adjusted round the cervix as high above the disease as possible. Care must be taken not to place the wire too high posteriorly for fear of cutting into Douglas' pouch. The circuit is closed, the wire kept at a dull red heat, and just sufficient traction maintained to keep the wire against the part to be severed. The operation requires several minutes. Hæmorrhage is usually avoided, but it may occur, and the possibility of secondary bleeding is not to be lost sight of.

The écraseur is more portable but less safe; the chain is not so easily manipulated and there is greater danger of cutting into Douglas' pouch. For this reason a curved écraseur is best.

Supravaginal amputation of the cervix.—The cervix is drawn down and a semicircular incision made in the anterior reflection of the vaginal mucous membrane with a scalpel or blunt-pointed scissors. The bladder is easily separated by the finger, and retracts upwards, carrying the ureters with it. The uterovesical pouch of peritoneum must not be opened. The cervix is then pulled forwards to the pubes, and a semicircular incision made through the posterior reflection of the vaginal mucous membrane, its extremities uniting with those of the anterior, so that the cervix is entirely free from the vagina. Douglas' pouch is liable to be opened, but this is of little consequence: if the posterior lip must be divided high up, it is better to cut into the pouch and remove the peritoneal covering with the portion amputated. The clearing of the cervix laterally is more difficult, on account of the firmness of the connective tissue and the presence of large branches of the uterine artery. Bleeding vessels should be secured at once with pressure-forceps and then tied. As soon as the cervix is freed all round, the knife is carried through the anterior wall at the required height, obliquely upwards towards the canal, and a conical portion excised from the interior. The anterior and posterior vaginal walls are stitched to the lips of the cervix, and sutures are also inserted laterally: they help to control the hæmorrhage. The ureters retract so that they are not in danger of being caught. By this operation a considerable portion of the body of the uterus may be removed as well as the cervix. It is not free from danger; even with the best statistics there is a mortality of twelve per cent.

Extirpation of the entire uterus.—This may be done either by abdominal section, or through the vagina; the mortality in the case of the former is so high (seventy-two per cent.) that the latter is usually performed.

The first steps are identical with those already described for supravaginal amputation of the cervix: the later ones admit of innumerable modifications. A circular incision is made in the vaginal vault, the bladder separated from the cervix as far as the uterovesical fold of peritoneum, and a free opening made into Douglas' pouch. Two fingers of the left hand are passed in over the fundus uteri into the vesico-uterine pouch, and the peritoneum is divided anteriorly by cutting down upon them through the wound in front of the cervix. The uterus is now free in front and behind.

The uterus must now be forcibly pulled down. If it can be brought outside and fully exposed, the broad ligaments may be secured by ligatures, and the uterus cut away. If this cannot be done the ligament must be clamped on one side as close to the uterus as possible, and then the tissues divided on the uterine side. There is no difficulty then in transfixing the other ligament, ligaturing it in two halves, and cutting it away. The clamp may either be left on for forty-eight hours or ligatures may be applied to this as well. If the ovaries and Fallopian tubes are allowed to remain, the stumps are sufficiently long to ligature easily; but if they are removed the ligatures are liable to slip.

Another method is to secure the broad ligaments in segments, first on one side and then on the other, drawing down the uterus bit by bit, in a zigzag manner.

Great care must be taken to avoid injury to the ureters or including them in the ligatures. These must be placed as near the cervix as possible; the ureters are less than half an inch to the side—higher up, they are a little farther off.

No sutures are required; the parts fall naturally into apposition. If the clamps are used and left they serve as a drain: if not, a glass tube must be passed into the peritoneal cavity and left for three or four days. If the discharge becomes offensive the wound must be thoroughly irrigated with an antiseptic by means of a catheter. The tube should be surrounded with antiseptic wool where it lies between the labia, but any further plugging is unnecessary. Hæmorrhage is the chief risk, either during or after the operation.

Caution must be exercised in separating the bladder, as its walls are very thin.

Mortality.—In amputation of the cervix with the cautery this is only 7 per cent.; in the supravaginal operation, the best results give 12 per cent.; but in complete extirpation it is as high as 28·6 per cent. This, however, cannot be regarded as final. Later results are much better, as might have been expected.

The **prognosis**, so far as cure is concerned, is very unsatisfactory. Recurrence either in the scar or in the periuterine tissue invariably occurs within a few months.

Cancer of the body is so rare and so seldom diagnosed in time that complete extirpation can hardly ever be performed.

OPERATIONS ABOUT THE VULVA AND VAGINA

Vascular tumours frequently occur at the orifice of the female urethra. They form small florid excrescences, sometimes attaining the size of a large pea, and give rise to increased frequency and pain on micturition, with hæmorrhage not unfrequently. Sometimes the symptoms bear some resemblance to those of calculus in the bladder. The mucous membrane around and extending up the urethra is often involved in the vascular growth. The tumour should be removed with a pair of fine-pointed scissors. If the mucous membrane is involved, it must be thoroughly treated with the cautery. The condition is very liable to recur.

Cysts of the labium are generally due to obstruction of the duct of Bartolin's gland. The cyst usually contains a glairy colourless fluid and is very liable to suppurate. Simple incision is not sufficient; the cyst invariably refills; if possible, it should be enucleated, and if this cannot be done a portion of the wall should be excised and the interior thoroughly cauterised with nitrate of silver.

Fibrous and fatty tumours are occasionally met with in the labium, and need no special comment.

Cysts of the vagina are of not very infrequent occurrence. They result from distension of mucous follicles, and sometimes attain the size of a small egg. When small they cause no trouble; when large they produce the symptoms of a foreign body, and may excite a chronic leucorrhœa. A portion of the cyst-wall should be excised and the interior of the sac freely cauterised. Enucleation should not be attempted.

Vesico-vaginal fistulæ result usually from sloughing following protracted and difficult labour, or ulceration around a foreign body impacted in the vagina. They give rise to great distress, owing to the constant escape of the urine and the irritation of the skin which it causes. The fistulæ vary much in size—some hardly admit a probe. In severe cases nearly the whole of the anterior wall of the vagina may be destroyed. When small, the opening may be detected by filling the bladder with milk; the point where it flows into the vagina will then be readily seen through a speculum. Vesico-vaginal fistula is most usually found about half an inch in front of the cervix uteri, sometimes close to it. Very occasionally it opens into the uterus itself—utero-vesical. When the fistula is very small, touching it with the actual cautery may succeed in closing it, but the proceeding usually terminates in failure, and an operation has to be undertaken. The patient may be placed either in the lithotomy or semiprone position, a duck-bill speculum introduced, and the uterus drawn down as low as possible with a tenaculum. The edges of the fistula should then be pared and brought together with sutures placed sufficiently close to prevent the passage of urine between them. The operation is often very tedious and difficult, on account of the difficulty in getting at the parts. Various ingenious needles and needle-holders have been invented with a view to overcome this. The bladder should be emptied by a catheter every eight hours for the first three days, and the stitches removed at the end of a week.

Recto-vaginal fistulæ may occur from the same causes as the preceding. They are commonly situated just within the entrance of the vagina, and may be treated in a similar way.

Laceration of the cervix uteri is also a result of labour. It is frequently attended with great hyperplasia and cystic degeneration; the lips tend to become everted (*ectropion*) and expose the inner surface of the cervical canal; this exposed surface very soon becomes denuded of epithelium, and is the source of a profuse catarrhal leucorrhœa; the condition persists indefinitely and may be the cause of many troubles, both local and general. 'Trachelorrhaphy' is the term applied to the operation proposed by Emmet for the repair of the laceration.

The patient is placed in the lithotomy position, and the uterus drawn down as far as possible by means of a tenaculum. The lacerated surfaces are well exposed, and a strip of mucous membrane removed on either side, leaving a broad tract undenuded between them; this tract will form the cervical canal and external os when the operation is completed; the flaps are then approximated and the sutures applied. The insertion of the sutures is not an easy matter, owing to the difficulty of getting at the parts and the toughness of the uterine tissue. A short, very stout, and slightly-curved needle is required and a strong needle-holder; the needle should be armed with a silk loop, and when it has been inserted through both lips, a silver wire threaded into the loop should be drawn into position; three or four sutures will be required on either side; they are best secured with a coil and clamped shot, and one end left long to facilitate removal. They may be removed on the seventh day, though some prefer to leave them until the tenth or even longer, as they seem to cause but little irritation. The operation should not be undertaken if there is any pelvic inflammation or cellulitis.

Rupture of the perineum is also an accident of labour. It may be 'partial' only, extending through the fourchette, or 'complete,' involving the sphincter ani and more or less of the recto-vaginal septum. An attempt should always be made to repair the injury at the time of the accident, although it is not always successful. Innumerable modifications have been proposed, and are employed by different operators in the repair of the perineum. The operation for complete rupture is as follows:—The bowels having been well opened and an enema administered the same morning, the patient is placed in the lithotomy position. An assistant stands on either side supporting the patient's knee under his arm; with one hand he draws the labia apart, and the other is free to assist the operator. Sitting in front of the patient, the operator inserts the first and second fingers of his left hand into the anus, and, putting the parts upon the stretch, he denudes the surface in the following manner:—At a point about half an inch external to the septum, the point of a scalpel or pair of scissors is passed into the tissues and carried along between the mucous surfaces of the vagina and rectum, dividing the septum into an anterior and posterior flap; the incision is terminated at an equidistant point upon the opposite side. Sometimes the line of incision is more or less marked out by an area of pale cicatricial tissue, but this is not always so. From either extremity of this transverse incision, another is carried forward to the lesser labium, and backward to the extremity of the anal orifice. In this manner an **H**-shaped incision is formed. The incisions must be freely made, or the surface denuded will be insufficient to form a strong perineum, and the flaps will require further dissecting up. Hæmorrhage is generally considerable, but can be kept in check by sponges and pressure-forceps; ligatures are not required. The free edge of the anterior flap is secured by a couple of forceps and held up by the assistants on either side; the sutures are then inserted. Some prefer to bring together the mucous membrane of the anus first, but no advantage is gained by this. Either

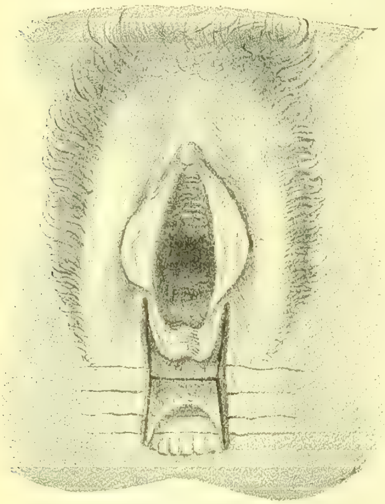

Fig. 476.—Incision in rupture of the perineum.

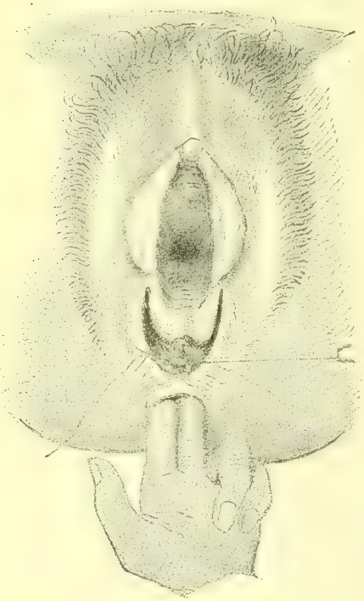

Fig. 477.—Method of inserting sutures.

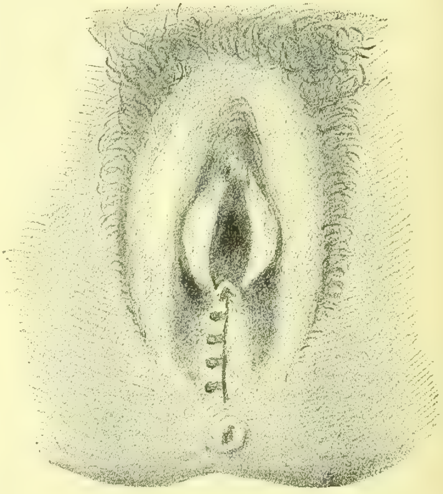

Fig. 478.—Sutures in a case of ruptured perineum.

silver wire or silkworm gut may be employed. Commencing at the lower part, the needle, which is moderately curved and mounted on a strong handle, is entered on one side about a quarter of an inch from the margin, or, as represented in the figure, into the denuded surface just within the margin. It is then carried between the layers of the recto-vaginal septum and brought out in the middle of the denuded surface, threaded with one end of the suture and withdrawn. The needle is then passed on the opposite side in a similar manner, the point being made to emerge at the same hole. It is threaded with the other end of the wire, withdrawn, and the suture thus completed. Three or four sutures are passed in this way through the recto-vaginal septum; one or two more are required in front, and one or two for the rectum. In passing the rectal and vaginal stitches care must be taken to enter them just at the cut edge of the mucous membrane, so that perfect adaptation of the raw surfaces may be ensured.

The sutures having been all inserted, the wound is carefully sponged, and the patient's knees brought together. The sutures are then tied firmly, but not too tightly, commencing from the lowest; the wire may either be twisted or secured with shot and coil. The wound is dressed with some absorbent wool and a T bandage applied. A morphia suppository should be administered, as the pain after the operation is often very considerable.

The repair of a partial rupture is generally unattended with much difficulty. A V-shaped incision is made through the integuments, the apex being just in front of the untorn remains of the perineum and the branches extending to the labium minus on either side. The anterior extremities of these are united by an incision which crosses the mucous membrane about an inch and a half from the apex, and the enclosed surface is then denuded; or the V-shaped flap may be dissected up and carried forwards. Sutures are inserted as in the previous operation.

The **after-treatment** consists in keeping the parts clean. The catheter is required every eight hours for some days. The bowels generally have a tendency to act of themselves about the fourth or fifth day. This may be encouraged by a mild aperient followed by an enema. It adds greatly to the discomfort of the patient to keep them confined by means of opium, and is quite unnecessary. The stitches may be removed about the eighth or tenth day.

CHAPTER XXVI

DISEASES OF THE BREAST

ABNORMAL DEVELOPMENT

Complete absence of the mammary gland is very rare; imperfect evolution at puberty, the breast retaining the infantile type, is not unfrequent, especially when the sexual organs are not developed.

Polymastia is more common. In most instances, the supernumerary structures are quite rudimentary, merely imperforate nipples with a linear depression and no areola; but sometimes they are well-formed glands, functionally active. Usually they lie in pairs along the line of the internal mammary artery, and are lower down upon the thorax; but a few instances are recorded in which they have been found above the normal level, in the median line, and even in distant parts of the body and upon the limbs. In addition to this, milk-producing tracts of integument, and, more rarely, small well-defined glands, are, as Champneys has pointed out, occasionally developed in the axillary region during the lying-in period.

Hypertrophy.—Proportionate overgrowth of all the parts of the breast is very rare, but cases of enormous and rapid enlargement, affecting the connective tissue only, are not uncommon in young women about the time of puberty, and even in men. It may affect one side or both, and the size may be so great that the patient is scarcely able to support the weight. The skin is thickened and rather coarser in texture, and the areola much larger than natural; but in other respects there is no very conspicuous alteration, and the consistence is perfectly uniform, which serves to distinguish this at once from enlargement due to rapidly growing tumours. Nothing is known as regards cause, and no treatment has any effect. Excision may be performed if the inconvenience becomes extreme, but the operation is not a light one. In a few cases the enlargement increases very seriously during pregnancy; in the majority the breast either fails to secrete altogether, or does so only to a very limited extent.

AFFECTIONS OF THE NIPPLE AND AREOLA

Inflammation of the nipple is of common occurrence during lactation, owing to the constant moisture and friction to which the part is subjected. The delicate epidermis is detached, leaving a superficial excoriation; this deepens into a fissure, usually between the rugæ or at the base, and in bad cases ends in serious ulceration. The pain when the part is touched, or an attempt is made at suckling, is simply agonising, and even when mammary abscess does not follow, often leads to grave impairment of health and strength.

It usually occurs with the first child, and in those whose nipples are ill-developed. During the period of pregnancy the skin should be carefully hardened by bathing it night and morning with spirits and water, and, if there is any need for it, the nipple should be gently drawn out by suction through a properly contrived tube. Afterwards the greatest care must be taken to keep it as dry as possible, and to cleanse it thoroughly every time the child leaves it. If there is the least excoriation, a mild or soothing ointment, such as almond oil, may be applied, and a shield should be used. If it continues and forms a fissure, it may be necessary to make use of a breast-pump, in order to save the patient the pain. Lead lotion; glycerine and tannic acid; styptic colloid, and similar remedies may be used at first (taking care that the nipple is cleansed before the child is put to it); but if the ulceration persists, it is better to touch the base with nitrate of silver, the pain being prevented by applying a solution of cocaine first. When the scab drops off, the epidermis is sound beneath, though very thin.

In addition to this, *eczema* of the nipple is occasionally met with during suckling, the locality being determined in all probability by the continual moisture; *abscesses* may occur in connection with the sebaceous glands of the areola; small *sebaceous cysts* and *papillomata* may develop; and, especially in wet-nurses, typical syphilitic *chancres* may form, the infection being derived from the fissures and mucous patches so commonly found at the angles of the mouths of infants suffering from hereditary disease.

Paget's Disease

Eczema of the nipple must be distinguished from a peculiar disease of the skin closely resembling it, which was first described by Paget, and which is of great importance from the frequency with which it ends in carcinoma. It affects the nipple and the areola. The surface in most is raw, intensely red, and finely granular, like that of an acute diffuse eczema, with a copious yellow and viscid discharge. In others it resembles a more chronic form, or it is like psoriasis, spreading beyond the areola, and covering the breast with scattered blotches. Nearly always there is itching and sometimes a sensation of burning. The base is always considerably thickened, and occasionally the ulceration is so extensive as to lead to destruction of the nipple.

The chief features distinguishing it from ordinary eczema are the well-defined margin it presents, and the evidence of deeper infiltration of the papillary layer of the corium. What proportion of cases ends in carcinoma (it is probably a large one), and how long it continues before this breaks out, are questions still unsettled, but the intimate connection of the two (though not their identity), may be considered as well established. The usual form is duct- or villous carcinoma, but the squamous type may occur.

The microscopic appearances, according to the earlier observers, merely presented a certain degree of proliferation of the deeper layer of the epithelium, with small-celled infiltration of the corium beneath, dilatation of the ducts, proliferation of the secreting cells in the acini, and finally the invasion of the epithelium and the development of carcinoma. Recently, however, another signification has been assigned by Darier, Wickham, and others, to certain peculiar highly refractile cells that are present in the epidermis and in the ducts of the milk and sweat glands, and are usually best developed at the growing margin.

They may be found in a scraping of the surface mixed with water, though their relation to the other cells can only be seen in sections. When small they are difficult to distinguish; as they increase in size a doubly refracting membrane forms around them; the other cells are pushed aside or altered in shape, and at length they develop into peculiar rounded bodies, much larger than the other cells, and either containing a mass of protoplasm, or else divided in two, very much in the fashion of a spore-bearing cyst. The irritation causes the superficial layers to desquamate; the inter-papillary processes grow longer; and at length the exudation accumulates to such an extent that the line of separation between the epithelium and the corium disappears.

These cells are said to be psorosperms or coccidia, and to belong to the sporozoa. Undoubtedly they are characteristic of the eczematous stage, and, according to Wickham, they occur not only in the consecutive carcinoma, but in other forms of cancer as well. Similar structures have been described in connection with molluscum contagiosum. Cultivation has not succeeded, but it is significant that after maceration in water for sixteen days, when all else had disappeared, they still remained intact.

Free removal is the only treatment. In many cases this means excision of the breast, as the nipple with the areola and the skin around must be taken away. It is possible, however, if the view that the disease is really the product of these psorosperms receives confirmation, that microscopic examination of obstinate cases of eczema may lead to earlier operation, while the disease is still limited, and before such drastic measures are necessary.

INFLAMMATION OF THE BREAST

Inflammation of the mammary gland may be acute or chronic. The latter (with chronic abscess), will be dealt with by itself, as its pathology is not certain.

Acute Inflammation

This is common at birth, puberty, and during lactation. At other times of life it may be caused by violence, but it is, comparatively speaking, rare, and syphilis, tubercle, and other specific diseases seldom attack the gland (chancre, of course, is different). The starting-point is usually some slight injury, such as friction or a blow. When it occurs at birth or puberty, it nearly always undergoes resolution, although suppuration may occur as in other parts. On the other hand, when it breaks out during lactation, suppuration is exceedingly common, the pyogenic organisms entering either through cracks and fissures of the nipple, or, possibly, finding their way up the ducts into the acini and the periacinous spaces.

1. *At birth.*—The breasts of infants of both sexes often secrete a milk-like fluid for a few days after birth. The gland is slightly swollen on the third or fourth day: this reaches its maximum by the end of the week, and then subsides. The only treatment necessary is to protect the part from injury. If the skin is very hot, or the swelling continues to increase, a compress wetted with warm lead lotion may be laid upon it, but no attempt should be made to rub the milk away. If suppuration occurs, it must be treated as an ordinary abscess.

2. *At puberty.*—The same thing is occasionally met with at this time,

owing to the rapid developmental changes that take place, but unless there is some injury, or the general health is greatly enfeebled, suppuration rarely occurs.

3. *During lactation.*—Towards the end of pregnancy, and during the first few weeks of lactation, inflammation of the mammary gland is exceedingly common, as might be expected from the extreme rapidity and extensive character of the changes through which it passes. It may be caused by any trivial injury, even the persistent drawing of an infant at a breast that cannot secrete, or the accumulation of the milk in one of the lobes. The whole gland, or the affected part, becomes even more tender than the rest, and very painful. When touched, it feels firm and dense, and if the area involved is large or near the surface, the skin is redder and warmer than that of the opposite side. In addition, there is usually a certain degree of feverishness, with thirst and anorexia, but it is difficult in most cases to say how far this arises from the affection of the gland. Distinct chills rarely occur without suppuration. The same thing may take place towards the end of prolonged lactation, especially in those women who are weakened by having borne many children in rapid succession, and, more rarely, at other times when the gland is entirely inactive.

The treatment depends upon the condition of the gland. If it is at rest, the inflammation is, as a rule, merely periglandular, and it is sufficient to confine the arm to the side (or, if the attack is severe, place the patient in the recumbent position), cover the breast with compresses moistened with lead lotion, and pack it so as to exert a certain amount of uniform gentle compression. Cold is very beneficial, and may be conveniently applied with Leiter's coils, but many patients are inclined to resent it. If, however, the gland is in a state of functional activity, this is not sufficient. The nipple must be carefully examined to see if there are any obstructed ducts. Hardened lobules must be gently rubbed away with friction towards the nipple. The milk must be drawn off with a breast-pump, or better with a suction-tube. The patient must be confined to bed; the breast well supported from beneath and at the side, and gentle pressure applied around the gland, except towards the axillary border. If this does not succeed, lead lotion or lead with opium or belladonna, may be applied; but, as a rule, if the attack is taken in time, these may be dispensed with. Constitutional measures must be guided by the condition of the patient. If the gland is at rest, or if the inflammation commences in the earlier weeks of lactation, and the attack is acute, and the bowels confined, saline purgatives are very beneficial. If, on the other hand, the patient is weak and exhausted, and has been already suckling too long, the bowels may require to be opened, but quinine and other tonics should be given instead.

Mammary Abscess

Suppuration occurring in the mammary gland at birth or puberty requires no special description; it follows inflammation as a natural consequence if the vitality of the tissues is much lowered, and if the pyogenic organisms are brought in sufficient numbers by the blood. That variety, however, which breaks out towards the end of pregnancy or during lactation, when the gland is in a state of full physiological activity, is very different.

It usually occurs either with the first child, in the first few weeks after parturition (and then it is nearly always associated with cracked or defective nipples), or, in those who have borne many children, as a result of unduly prolonged lactation. One or more of the lobules become inflamed; the pyogenic organisms gain entrance, sometimes through the blood-stream, much more frequently through some minute excoriation of the nipple (the lymphatics of the breast radiate from this point through the gland to its base, and then for the most part run on the surface of the pectoral fascia to the axilla), or, perhaps, through the ducts themselves; and suppuration follows, diffuse or limited, according to the size of the area inflamed and the vitality of the tissues involved.

It is usual to divide mammary abscesses into three classes, according to their situation—superficial, intraglandular, and submammary.

(*a*) *Superficial abscesses.*—These require no special description; they should be opened and drained as soon as the diagnosis is made, to prevent the skin becoming undermined.

(*b*) *Intraglandular* ones are more serious. It is probable that they may begin either in the lobes themselves, or in the loose cellular tissue around them; but it is rarely possible to distinguish one from the other. The earlier symptoms, those due to the inflammation, have been described already; suppuration may begin acutely, with a definite chill; more frequently the pain and swelling merely grow worse and worse; the breast becomes larger and larger (the nipple often being retracted owing to the tension on the ducts) without its being possible to indicate any definite locality as the seat of the mischief, and the constitutional symptoms more and more severe. After a few days, when the tough fibrous tissue that surrounds the suppurating lobule (if it commences in one) has given way, there is often a certain degree of improvement; the pain is less severe, and the temperature falls a little; then, by degrees, the skin at one spot becomes thickened, œdematous, and tied down, giving some indication as to the direction in which the suppuration is progressing, and at length one spot softer than the rest can be made out in the centre of the swelling.

The sooner the pus is evacuated the better, but it is necessary to wait until some idea can be gained as to its position and the direction it is following; exploratory operations in a breast in a state of full physiological activity are not advisable. The incision should be free, radiating from the nipple so as not to cut the ducts across, and suitably arranged for drainage. As the interior of the abscess is always irregular in shape, it should be thoroughly explored with the finger; a drainage-tube introduced into every pocket; and the whole circumference packed with soft absorbent dressings, so that the fluid that exudes may be driven towards the opening. More than one incision may be required if the abscess is allowed to burrow in all directions through the gland before it is opened. Such cases, and still more those in which the pus is left to work its way out as it pleases, often leave irregular sinuses which persist for years, draining the patient's strength, and ultimately leading to the destruction of the gland as a secreting organ.

(*c*) *Submammary* abscesses are fortunately rare. They may commence in the deeper lobes of the gland and spread through the subjacent fascia, or be due to direct infection through the lymphatics. In many cases they are associated with symptoms of pyæmia, and probably they are often embolic. The breast itself is but little affected; it is thrust out from the chest-wall and floats as on a water-bed. Sometimes they develop insidiously; more often they are attended with very severe symptoms. If left, the skin usually gives way below the gland; but frequently large tracts slough, leaving great cavities fringed with blue, congested, overhanging flaps. I have known an abscess of this kind extend from the sternum to the spine, undermining the skin and destroying the cellular tissue half-way round the body before it broke. Great care must be taken in opening these to secure efficient drainage, and to bring the opposing surfaces into accurate contact, so that no decomposing pus may be retained in outlying pockets.

Chronic Inflammation

Chronic interstitial mastitis, affecting one or more of the lobules, is of very great importance from the pain and anxiety it occasions and from the difficulty of distinguishing it from the early stage of scirrhus. The interacinous spaces are filled with a small-celled infiltration, which becomes organised and contracts into dense cicatricial tissue. The acini disappear or become converted into retention cysts, filled with a clear but often coloured liquid; and by degrees the lobule becomes changed into a hardened mass of very irregular shape, adherent to the structures around (so that it cannot be pushed about like a fibro-adenoma); and sometimes, if it involves one of the larger ducts, attended with retraction of the nipple.

No cause can be found in the majority of cases. It is most common about the menopause; it is often associated with disorders of menstruation, and at each period it usually becomes painful and tender; but, on the other hand, it may occur at any age and in those who are to all appearance perfectly healthy. Pain, often of a neuralgic character and sometimes very severe, and made much worse by handling, is usually the first thing noticed; and the induration is only found on examination.

The **diagnosis**, so long as the patient is under thirty years of age, is not very difficult (although the possibility of carcinoma must not be overlooked); in older ones it rests chiefly upon the physical signs. The hardness is not of that stony description characteristic of contracting scirrhus; the surface is usually more nodular (from the presence of cysts); it may vary in size at each menstrual period; sometimes there are several separate lobules in the same condition, either in the same or in the other breast; and it may have been present too long. In many cases, however, the difficulty is so great and the risk so disproportionate that every endeavour should be made to induce the patient to submit to an exploratory incision; the question can be settled by the microscope while the patient is still under the anæsthetic.

The **treatment** of chronic interstitial mastitis is very unsatisfactory. Sometimes it slowly undergoes resolution or disappears so far that the patient takes no more notice of it, but it is rarely possible to connect this with any particular remedy. Paget recommends small doses of iodide of potash with liquor potassæ, well diluted; and of course any menstrual irregularity must receive careful attention. Tonics (especially iron) often succeed better than anything else; but the chief thing is to protect the breast against every source of irritation, and to withdraw it as far as possible from notice, by covering it with a well-shaped belladonna plaster.

Chronic Abscess

Thick-walled chronic abscesses are occasionally met with in the breast without any definite sign of inflammation around them. They may commence during lactation, or after a miscarriage, but they are also met with independently of any such cause, after injury. In some instances they may be of tubercular origin, the caseous material gradually becoming surrounded and encapsuled. Their importance is derived from the extreme difficulty of distinguishing between them and carcinoma. Like it, they are a distinct addition to the substance of the gland (in which they differ from chronic interstitial mastitis); they are intensely hard, painful when handled, and adherent to the structures around; and sometimes they drag distinctly upon the skin and the nipple. It is true that a certain amount of œdema may be present over the swelling, but this by itself is too slight a sign on which to base so important a diagnosis; and they have been known to last for months and even years, without any other change than a slight increase in size.

The only treatment is free incision and drainage, scraping the interior out thoroughly if the wall is dense and hard. If the diagnosis is in the least uncertain, a preliminary incision should always be made before attempting anything further; for want of it the gland has before now been removed under the impression that the case was one of scirrhus.

Gummata are met with in the breast, but very seldom. Masses of caseous material, possibly of tuberculous origin, are rather more common, forming a considerable proportion of the so-called galactoceles. If allowed to break, they leave chronic ulcers and sinuses fringed with congested flaps of skin, similar to those met with in other parts of the body.

TUMOURS OF THE BREAST

These are simple or malignant. The former include the various kinds of cyst and the different forms of mammary glandular tumour; the latter, carcinoma and sarcoma. In addition, melanotic sarcoma and papilloma may grow from the nipple and areola; squamous carcinoma may extend inwards from the skin as a result of Paget's disease (usually this gives rise to duct-cancer); and nævi, lipoma, chondroma, and some other forms may occur; but they do not so much belong to the breast as to the structures around.

In the case of a suspected tumour, the first proceeding is to exclude lobular induration. The patient should be placed in a semi-recumbent position; the dress arranged so that the whole of the gland is uncovered; and the arm freed from all restraint. Then, before the fingers are allowed to feel it, the palm of the hand should be laid flat upon the suspected spot, and made to roll the lobules gently over each other. If there is a new growth it stands out distinctly as an addition to the gland; if, on the other hand, there is merely lobular induration, it can scarcely be felt unless the breast is very thin. If this precaution is neglected, and the hardened tissue is grasped with the fingers first, whatever its nature, it feels exactly like a tumour. Even this, however, fails to distinguish simple induration from malignant infiltration (scirrhus) in its early stages.

No examination is complete without thorough investigation of the axilla.

The arm should be only moderately abducted, and the glands along the margin of the pectoral muscle felt for first, then those that lie along the axillary vein and at the apex. Unfortunately, even with the greatest care, it is only possible to detect them when they have attained a considerable size.

Cysts

Cysts of the breast may be simple or filled to a greater or less extent with new growths of various kinds—papillomatous, adenomatous, sarcomatous, or carcinomatous. As the importance of the latter class is derived from the solid structures associated with them, they will be dealt with later, under their several headings.

Dermoid and hydatid cysts have been known to occur, but they are very rare: by far the majority of cysts are developed in connection either with the fibrous stroma or the gland-tissue.

Cysts developed from the fibrous stroma (*serous cysts*) are usually single and more or less globular in shape, but they may be multiple and very irregular. Their walls are formed of fibrous tissue lined with epithelioid cells, and they contain a clear, albuminous liquid. The mode of origin is very doubtful, but possibly, like the similar cysts occasionally met with in the neck, they are connected with the lymphatic interstices.

Glandular cysts.—Of these there is a great variety.

(*a*) *Involution cysts.*—After the period of activity is past, the mammary gland not unfrequently becomes studded with numbers of small cysts, developed not so much from the acini (which atrophy and disappear) as from the minute ducts. If there is a coincident development of fat, this change is not noticed; but, in thin people, and especially when the change is prominently developed in one particular lobule, it may give rise to great uneasiness, owing to the peculiar hardness of the cysts. Their rounded shape, however, the free mobility, the absence of any adhesions, and the presence in nearly every case of a similar transformation, either in other parts of the same breast or in the opposite one, are usually sufficient to make the diagnosis certain.

(*b*) *Cystic degeneration.*—This is more rare. The whole gland, or the greater part of one, becomes studded with myriads of minute cysts, developed from the acini. They are lined when small with low columnar epithelium; as they increase in diameter the cells become flatter, until in the largest (which may be the size of a small marble), they are almost pavement-like; and they contain a clear albuminous fluid, which may be green or brown, and even almost black in colour, from the admixture of hæmoglobin. In some cases the basement membrane of the acini is greatly thickened as well. This has nothing to do with the period of involution: it occurs at a much younger age, and only affects one, and sometimes only part of one of the glands, but its real nature is very obscure. Clinically, it causes a rapid uneven enlargement, with the development of very irregular hardened nodules; and if the cysts are near the surface, and sufficiently large to admit of recognition, it is usually taken for a variety of cystic sarcoma.

(*c*) *Cysts due to chronic inflammation.*—Minute cysts are often present in chronic interstitial mastitis, caused by the constriction of the ducts; but, except for the way in which they add to the size of the lobule and increase the irregularity of its outline and the hardness of its texture, they are of but little importance.

(*d*) *Retention cysts.*—These are the largest of the simple glandular cysts: sometimes attaining the size of a small orange. They may be single or multiple, and occur at any age. Undoubtedly, they are developed from the ducts (whence their name, *duct-cysts*), and not unfrequently some of their contents can be squeezed out (so that they are not all due to simple obstruction); but nothing is known as to the cause of their development. Their contents are usually clear and albuminous (sometimes coloured), and many of them contain papillary growths. The diagnosis rests chiefly upon the even globular outline, and the absence of pain and of adhesions; but, especially when they are deeply seated and in a large breast, it is often impossible, owing to their hardness, to distinguish them from chronic abscess or carcinoma without an exploratory puncture. As, however, it is impossible to say from this alone whether there is an intracystic growth or not, they should always be incised, and, if they are really simple, drained or wiped out with a sponge dipped in some strong antiseptic, so as to ensure their obliteration.

(*e*) *Galactoceles* or *milk-cysts* may be caused by rupture or distension of one of the ducts during lactation, usually in one of the early months. Sometimes there is a history of injury. The swelling makes its first appearance rapidly, and in some of the cases has varied considerably in size, increasing during the actual time of suckling, and diminishing to some extent in the intervals by condensation. Spontaneous cure does not seem to occur: the contents gradually become more and more inspissated, but the tumour does not disappear. In some instances, it has attained an enormous size.

If the tumour is of rapid growth, the child must be weaned and every endeavour made to arrest the secretion of milk. The size of the swelling should be reduced by aspiration, and the increase checked as far as possible by gentle pressure. Afterwards the cavity must be drained with great care, to avoid suppuration. Small cysts, and those which show no tendency to increase, may be left until the period of suckling has expired. It is probable, however, that many of the smaller stationary galactoceles are really caseous abscesses, the contents of which are, more or less, dried up, and which possibly were originally of tuberculous origin. The same may be true of the calcareous masses which have occasionally been described.

MAMMARY GLANDULAR TUMOUR

The mammary gland, like the parotid and thyroid, is liable to its own form of tumour. The histological elements that compose it are the same as those met with in other growths; but its features are so distinctive that, like parotid glandular tumour, for example, it requires separate description.

It originates in connection with the lobules of the breast after puberty, sometimes one element, sometimes another, being in excess. Where it is composed chiefly of glandular structures, it is known as an *adenoma*; if there is a fair proportion of fibrous tissue as well (the most common form), as *fibro-adenoma.* In some cases the ducts and acini are flattened into slits; in others they are enlarged into cysts of all sizes (*cystic adenoma*). Sometimes these cysts are simple, lined with one or more layers of epithelial cells, and contain a clear gelatinous or coloured fluid; sometimes there are growths of various character (adenomatous or papillomatous) inside (*proliferous cysts*). In other varieties, again, the matrix of the tumour, instead of retaining the character of firm fibrous tissue, resembles that of a sarcoma, and from this further forms arise : *adenosarcoma*, when the gland-tissue is not enlarged out of proportion to the rest; *cystic sarcoma* (serocystic sarcoma or Brodie's disease) when there are cysts developed from the acini or ducts filled with soft sarcomatous masses sprouting from their walls. These tumours may occur at any age after puberty; there may be only one, or there may be any number in one or both breasts; if left they may grow to any size, especially the sarcomatous forms; and at length the skin over them may give way so that they develop into gigantic fungating masses, causing the death of the patient by exhaustion; but they do not affect the surrounding lobules of the gland (except by their pressure) or spread through the lymphatics or the blood-vessels, and (though it often happens that other smaller ones grow up to replace them) they do not recur after free removal. The slow-growing fibrous forms are very common in young women; the more rapid ones rarely occur before thirty years of age; but sometimes a tumour that has scarcely made any progress for months together suddenly begins to grow, and then it may attain an enormous size. Cysts may occur at any time of life.

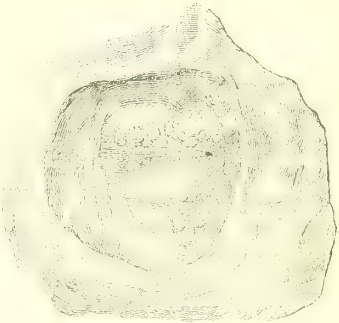

Fig. 479.—Cystic tumour in breast, with pedunculated adenomatous growth.

Diagnosis.—The distinguishing feature of mammary glandular tumours is their mobility, especially while they are small; they seem capable of being pushed among the other lobules in all directions. Those that grow rapidly, and are allowed to attain a large size, lose this feature to a great extent.

Adenomata and fibroadenomata are particularly hard, and often nodular on the surface; adenosarcomata are softer, growing more rapidly, and the skin over them is covered with enlarged and dilated veins. Cystic adenoma can usually be recognised by the rounded outline and the elastic sensation it gives when pressed upon; moreover, there is not uncommonly a history of a serous or blood-stained discharge from the nipple, and sometimes the tumour has distinctly varied in size; but it is impossible to form any idea of the character and scarcely any as to the presence of intracystic growths. They may be large or small, sarcomatous or papillary; the fluid around them altogether conceals their rate of increase. Pain is seldom complained of in the case of the larger growths, although their weight and size may prove a serious inconvenience; but some of the smaller and harder ones, especially those that occur in young unmarried women, are not unfrequently the seat of intense neuralgia, especially after handling and during the menstrual period. The skin never becomes involved or the nipple retracted unless the growth has attained a very large size, or has spread among the other lobules of the gland.

Treatment.—Excision of the tumour is always advisable. It is true that many of the smaller ones persist for a very considerable time without showing any change, but there can be no certainty of this, and not unfrequently after remaining latent for years they suddenly begin to grow at a rapid rate. The gland itself should never be removed unless the tumour is so large and so intimately fused with it that it is unavoidable; and unless it is actually adherent, no skin need be sacrificed.

The plan of operation depends upon the size and situation of the tumour. If it is small and superficial it may be fixed between the finger and thumb of the left hand, and a single incision radiating from the nipple, made down to it and through its capsule; as a rule it shells out readily, though sometimes a certain amount of dissection is required. If it is deeply placed, or if there are several, it is better to adopt the method advocated by Thomas, of New York, and reflect the breast upwards from below, the incision being made in the groove beneath the gland so that no scar is visible. Fortunately these tumours are for the most part so freely movable in the breast-tissue, that, if there are several of them, a single incision will usually serve for all. For the larger ones no rules can be laid down, but, especially if the patient is nearing middle life, and the gland-tissue is much involved, it is often simpler and more satisfactory to remove the whole. Pressure should be carefully arranged afterwards, so as to ensure complete obliteration of the cavity left. Whether a drainage-tube should be used or not depends upon the amount of bruising.

Sarcoma

All varieties of sarcoma, with all their forms of secondary degeneration, are occasionally met with in the breast, but the only one at all common is the spindle-celled. It may occur at any age after puberty, and forms a soft, rounded or lobulated mass, pushing the gland on one side and very difficult to distinguish, at first at least, from an adenosarcoma. If there are cysts in it, due to softening or hæmorrhage, or even if there are isolated masses of softer round-celled growth in the middle of the firmer part, the diagnosis may be impossible.

Growth at first is usually slow: after a little while, however, the tumour begins to increase with great rapidity, and very soon it develops into a gigantic mass, which, if left to itself, ulcerates through the skin and forms a huge fungating excrescence that bleeds with the slightest touch. The only treatment is free excision, not only of the tumour, but of the capsule that surrounds it. Afterwards the most careful watch must be kept. Infection of the glands or of distant organs is rare, but local recurrence is exceedingly common, and each secondary growth increases in size more rapidly than the one that preceded it. Operations may have to be performed again and again; sometimes at last the tendency to recurrence is overcome; more frequently before this occurs the time arrives when surgical interference is no longer practicable.

Carcinoma

Carcinoma of the breast may be glandular, columnar-celled, or squamous. Of these the two last form together but a very small percentage of the whole. The columnar-celled type grows from the ducts (*duct or villous cancer*); it can only be diagnosed by the cystic appearance it presents on section, although its nature may be suspected if there is a blood-stained or milky discharge from the nipple; the squamous one spreads by continuity from the areola and is sometimes secondary to Paget's disease.

Glandular carcinoma presents many different forms, according to the relative proportion of the cells and stroma that compose it. The more rapidly growing varieties as a rule occur in younger patients with full breasts, but there are many exceptions.

(*a*) *Atrophic scirrhus.*—This is the hardest and slowest in its growth of all : the contraction is so extreme that the breast grows smaller and more withered the longer it lasts, and the skin and the surrounding structures become bound together as if by dense cicatricial tissue. It is usually met with in the thin, wasted breasts of old people, and it may last many years before it proves fatal ; when it is cut across it creaks and grates before the knife ; the surface becomes markedly cupped, but there is little or no cancer-juice. Its colour is greyish-white, with streaks and dots of yellow, and it has no outline, but shades off imperceptibly into the healthy tissues around.

(*b*) *Nodular scirrhus.*—The wasting is much less, so that, although the contraction of the stroma renders the swelling intensely hard, it is not sufficient to cause a diminution in size. There is a distinct hard nodule which can be felt as an addition to the breast gland when the palm of the hand is laid flat upon it. The cut section is much the same as the former, but it is more juicy, and the fibrous bands that traverse it are not so inextricably welded together.

(*c*) *Infiltrating scirrhus.*—This differs, not only in the rapidity of its growth, and the absence of wasting, but in the peculiar mode of its extension ; it seems to spread, not by gradual continuity of structure, but by leaps and bounds, and so quickly that it may even seem to originate in many separate points at the same time. Its course, so far as life is concerned, is proportionately fatal. There are two varieties of it, according to whether it involves the glandular tissue or the skin. In the former, the whole breast rapidly becomes enlarged ; no definite tumour can be felt ; the nipple is buried by the increased growth around it as much as by its own retraction ; and the whole gland is converted into a solid mass of carcinoma. In the latter, the skin is chiefly involved ; it becomes peculiarly hard, thick, dense, and coarse (it has been compared to a pig-skin saddle) ; the colour changes to a dusky red ; the texture is completely altered ; it does not move on the parts beneath, and it cannot be pinched up into folds. Minor degrees of this are often seen over a carcinoma as it approaches the surface, but in this particular form the disease may spread all round one side of the thorax (*cancer en cuirasse*), and invest it with an absolutely rigid casing within the space of a few weeks.

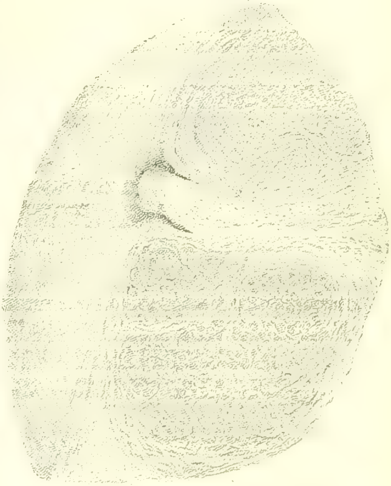

FIG. 480.—Scirrhus with retracted nipple, undergoing colloid transformation.

The cut surface, owing to the softness and rapidity of growth, often does not cup at all ; but the cancer-juice on scraping is very abundant.

(*d*) *Encephaloid.*—Very soft glandular carcinoma, such as occurs in the testicle for example, is seldom met with in the breast ; many of the cases formerly described as such were in all probability sarcomata ; but the softer infiltrating forms are sometimes termed encephaloid from the striking contrast they present to the hardness of scirrhus. As a rule their growth is even more rapid than that of the preceding one.

In addition to these, *cystic carcinoma* has been described (the cysts being due to hæmorrhage or softening); and occasionally *colloid degeneration* is met with; but though this form of carcinoma is peculiar from the length of time it often lasts, it is not a distinct variety.

Etiology.—Cancer in the breast is very rare before thirty years of age; then it becomes more and more frequent until nearly fifty; after that it begins to diminish again (not only absolutely, but relatively to the number living); but it may start even in extreme old age. Marriage, child-bearing, suckling or not, and disorders of menstruation have never been proved to have any relation to it. It occurs in all social conditions, and in those who have enjoyed perfect health as much as, and possibly even more than, in others. It may follow a blow, though of course too much reliance must not be placed upon ordinary histories; and in a small proportion of cases it follows on chronic lobular induration, or develops in the neighbourhood of an old abscess. Whether locality or climatic conditions have any effect is very uncertain, and, probably, owing to the freedom of communication at the present day, will never be proved. Statistics show that it is not hereditary, but as individual cases of the most striking character are met with from time to time, it is probable that this statement is too sweeping, and that the tendency exists, though it may not be marked, and may require other circumstances for its development. It is an old observation that carcinoma rarely develops during pregnancy or lactation; and it has been said that a tumour that makes its appearance during either of these periods is almost certainly not cancer; but the symptoms at its first commencement are so exceedingly slight, and the changes through which the gland-tissue passes are so extensive, that this is very difficult to prove.

Symptoms.—These naturally present considerable variety, but essentially they may be reduced to two.

1. The presence of a tumour.—Unfortunately this fails to distinguish commencing scirrhus from chronic lobular induration, as in both there may be an actual diminution in size.

2. The way in which the tumour infiltrates and (like a crab that has been turned upon its back) drags towards itself everything around.—The same thing is true, though to a less extent, of chronic abscess, and this renders the difficulty of separating one from the other so great.

The first appearance of scirrhus is an ill-defined, intensely hard nodule in the substance of the gland. There is no margin; it cannot be separated from the lobules around it or moved freely in any direction. Whether, when the hand is laid upon it, it feels like an addition to the gland or not, depends upon the relative amount of new growth and contraction. In a little while it becomes more definite. If it is near the skin this is dimpled over it, the vertical septa of connective tissue and the deep ends of the cutaneous glands being dragged down first; the nipple (if it is near one of the larger ducts) is treated in the same way (often this can be best seen by gently pulling the growth to one side); and even the fascia beneath the gland is caught as well. Soon some of the intercostal nerves are involved, and then it gives rise to the most intense pain, sharp and stabbing, especially at night and when the breast is handled, sometimes limited to the gland, but more often spreading round the thorax, over the shoulder or down the arm. In a little while the tumour grows more prominent, still retaining its extreme hardness; the skin is bound down over a wider area and becomes a dusky red; the lymphatic glands in the axilla are enlarged; the nipple is perhaps entirely withdrawn; and by-and-by a small fissure makes its appearance about the centre of the swelling. At first this is covered by a scab of dried epidermis; soon this falls off and a typical scirrhous ulcer is left, with a pale waxy base, and raised, hardened, and rolled-in edges.

The subsequent course is of the same character. The patient's health begins to fail, although it may be some time before there is a definite appearance of cachexia. The ulcer steadily increases in size; if the cancer is soft and of rapid growth it may fungate and bleed; more often it merely melts away on the surface, giving off a discharge of a peculiarly offensive description. The axillary glands become matted together; the veins and lymphatics are closed; œdema of the arm sets in; the brachial plexus is compressed, causing the most intense neuralgia; then the supra-clavicular glands are attacked; pleurisy perhaps follows (the lymphatics from the inner half of the breast communicate freely through the intercostal spaces with those of the mediastinum and the pleura); and finally secondary deposits make their appearance in the liver, lungs, vertebræ, or other parts of the body.

The relative prominence of these symptoms differs of course very greatly. In some the rapidity of the growth is the chief feature: a soft, elastic, almost fluctuating swelling seems to take the place of the breast almost at once. In others the skin is the part attacked, the extreme form being that known as *cancer en cuirasse*. In a third class again ulceration begins before there is much growth, and persists, quietly spreading year after year. The pain, the implication of the skin, the retraction of the nipple and the fixation to the pectoral beneath (best seen when the muscle is in action) depend largely upon the accidental position of the growth; and so, to some extent, does the direction in which lymphatic infection spreads.

Diagnosis.—When the skin is involved, the nipple retracted, and the axillary glands enlarged (the stage at which the majority of patients present themselves for treatment) the diagnosis is easy, but too late. If there is to be any hope of definitely curing a patient suffering from cancer of the breast, the diagnosis must be made before any one of these three is present.

In the case of scirrhus the chief difficulty occurs in connection with *chronic lobular mastitis*, *chronic abscess*, *fibro-adenoma*, and *deep-seated cysts*. The softer varieties are frequently not distinguishable from *adeno-sarcoma*, *cysto-sarcoma*, or *true sarcoma*, but this is less material, as in either case free and early exploration is the rule.

The following are the most important points:—

(*a*) *Age.*—Carcinoma is very rare before thirty, and rare before thirty-five years of age; the other affections may occur at any time of life.

(*b*) *Fixity.*—Unfortunately, chronic abscess and chronic induration are as adherent to the lobules around as scirrhus; and in any case, when the growth is small and deeply seated in a full breast, this is most difficult to estimate.

(*c*) *Consistence.*—Scirrhus is of stony hardness, the others are not; but the difference is often inappreciable. A cyst near the surface is tense and elastic; chronic induration is often very irregular in its outline; and œdema is not unfrequently present over a chronic abscess.

(*d*) *Period of origin.*—Chronic abscess is said to occur most frequently during lactation or after a miscarriage. This is not the case with carcinoma, although it is impossible to deny that it may happen.

(*e*) *Multiplicity.*—If there are several nodules, especially if they are at some distance from each other (so that they are not caused by latent extension), or if there is a symmetrical induration in the other breast, it is strongly against carcinoma, and in favour of chronic mastitis.

(*f*) *Shape.*—This is of little service; but if the swelling is tense and globular, or if one or more globular enlargements can be detected on it, it is almost certainly cystic, in part at least.

(*g*) *Tenderness* is very important. In chronic induration the lobe is nearly always very tender on pressure, or on trying to separate it from the rest of the gland; carcinoma, on the other hand, (in the early stage) is tolerably insensitive. This is often shown by the way in which the nodule is discovered; in the one case the tenderness attracts the attention of the patient, in the other it is the presence of a hardened lump.

(*h*) *Pain.*—The pain of carcinoma, when it once begins, is nearly always described voluntarily by the patients as sharp and stabbing. That of chronic induration is often severe after handling (especially in women too young for scirrhus), but it is neuralgic in character; there are neuralgic points down the axillary line on the side of the thorax where the nerves perforate the intercostal muscles, and it varies in intensity at each menstrual period. Sometimes the patient is positive that the size of the suspected lobe varies too.

(*i*) *Dimpling of the skin.*—The skin is adherent over inflammatory swellings, and sometimes over large rapidly growing tumours, other than carcinoma, but the dimpling of scirrhus is different. At the first it is due to the dragging on the suspensory ligaments of the breast which pass vertically inwards from the surface; later the ends of the cutaneous glands are involved, and then the subcutaneous tissue and the skin itself. This stage is of very great importance, not so much for the diagnosis of the disease, but as a criterion of the extent to which it has spread—practically it may be taken that the lymphatics are involved as well, whether they can be felt or not.

(*k*) *Retraction of the nipple* is to a large extent a question of locality; if, that is to say, scirrhus develops near its base, retraction appears very early; if, on the other hand, it is far away, very late. It is due to the dragging upon the larger ducts, and it may arise from many other causes besides scirrhus. It may, for example, be congenital; or it may be the result of inflammation, past or present; or it may be due to some other form of tumour pushing the ducts upon one side, or causing uneven enlargement of the gland. Retraction, therefore, is not distinctive, but when it occurs in connection with an indurated lobule, before this has attained any size, its presence is highly significant.

Finally, if the diagnosis is in the least degree doubtful, an exploratory puncture should be made under an anæsthetic, and if this is not satisfactory, a free incision with full permission to proceed farther, if it is thought advisable.

Prognosis.—The duration of life, in cases of cancer of the breast that are not operated upon, is under three years on the average of a large number; but individual instances vary very greatly. The soft and rapidly infiltrating growths, and especially those which implicate the skin to a large extent, may prove fatal within six months; atrophic scirrhus, on the other hand, may last for ten and even twenty years unchanged. Death may be due to exhaustion, septicæmia from the absorption of the foul discharge, or to the occurrence of secondary deposits. Hæmorrhage from the surface of the sore, or pleurisy due to direct extension along the lymphatics, is not unfrequently the immediate cause.

Treatment.—Cancer of the breast can only be cured by complete excision at the very earliest moment; it can, it is true, be removed by caustics, but the process is slower, more painful, and absolutely uncertain. Whether an operation is to be recommended or not, depends upon: (*a*) the condition of the patient; (*b*) the character of the breast; (*c*) the nature of the growth; and (*d*) the stage it has reached.

(*a*) *The patient.*—In this, the surgeon must be guided by the ordinary rules for operating. Excision of the breast is a very favourable operation (so far as immediate results are concerned—the older statistics are quite valueless), if the patients are properly selected; primary union is the rule, but no operation should be undertaken in cases of renal disease, diabetes, advanced pregnancy, cirrhosis of the liver, or extreme obesity, especially if associated with shortness of breath and a tendency to bronchitis. Age of itself is no bar.

(*b*) *The breast.*—The larger the breast, whether due to the gland itself or to an accumulation of fat around it, the more unfavourable the operation in every way; the wound is larger (in some cases the gland has outlying lobules under the margin of the pectoral muscle); complete removal is more difficult; the growth is almost certainly not of the nodular or atrophic variety; lymphatic enlargement is more difficult to detect; and if there is a thick layer of fat, the wound does not heal so well.

(*c*) *The nature of the growth.*—At one extreme are the very chronic cases, at the other the rapidly infiltrating ones. With regard to the former, it is sometimes questionable whether operation is advisable—the expectation of life without its being done is so much better than in the other varieties; on the other hand, there is the certainty that ultimately it will prove fatal; and the possibility, with but slight risk (for these cases are very favourable ones), of freeing the patient from a ceaseless source of anxiety and pain. With regard to the latter, it must be admitted the results are exceedingly bad; it seems impossible to operate soon enough, and the actual prolongation of life is very short. Whether, when the absolute importance of early operation, even in suspicious cases, comes to be more widely recognised, the results will be improved upon, especially if the axillary glands are removed as well, remains to be seen.

(*d*) *The stage the growth has reached.*—If complete excision is performed before there is any dimpling of the skin or retraction of the nipple, prolongation of life is certain (taking, of course, into consideration the risk of the operation), and freedom from recurrence highly probable, especially if the growth is one of the harder kinds. It is for this reason that it is so important to advise an exploratory operation in every case of chronic induration of the breast, in a patient nearing forty years of age, if the diagnosis is in the least doubtful.

If the skin is dimpled, relief may be promised, and (almost certainly) local recurrence prevented again under the same conditions (complete excision, and one of the harder varieties); but absolute cure is much more questionable. In such a case it is impossible to prove that the axillary glands are not involved, and consequently the whole of the loose cellular tissue and the lymphatics that cover the mammary portion of the pectoral muscle and fill the axilla, must be systematically dissected out. The fact that the glands cannot be felt means nothing.

Some advise that this precaution should be adopted in every case of carcinoma, and refuse the term ‘complete’ to every operation in which it is not done. Undoubtedly it increases the patient's chance of ultimate cure; and, accordingly, where it does not too much increase the immediate risk, it should certainly be practised.

In the later stages, when the skin is extensively adherent, and the glands are definitely enlarged and perhaps matted together, it must depend entirely upon the patient. Cure is very doubtful; relief from pain, and from the prospect of an intensely offensive and perhaps fungating ulcer, is fairly certain (provided the whole of the infected skin can be freely removed), but no more, and often the shock necessarily attendant upon such an operation (even when primary union is assured), seems to make the disease light up elsewhere and grow with redoubled vigour. If the supra-clavicular glands are involved; if the breast is adherent to the chest-wall (not the pectoral muscle, but the fascia nearer the sternum), so that there is reason to apprehend the speedy onset of pleurisy; if there is œdema of the arms, or if nodules are perceptible in the liver or elsewhere, operations are not advisable unless there are definite local reasons for it, such as intense pain or imminent hæmorrhage.

Recurrence.—Unhappily this is the rule. The average time seems to be about a twelvemonth. It may take place locally, in the cicatrix or near it (sometimes in the scars left by the sutures), or in the axilla. The question of further operation must be determined by the same consideration as in the previous case; permanent cure is, it is true, probably not to be hoped for, but, with very small risk and suffering, it is sometimes possible to enable a patient to live with a fair amount of comfort and without pain, until visceral lesions make their appearance.

The **treatment** of carcinoma of the breast, if operation is declined, is very unsatisfactory. Arsenic in continually increasing doses has been recommended, but it has not been proved to have any real influence. Cold lead lotion checks the growth a little by reducing the hyperæmia, but it must be kept up continuously; poulticing makes it increase at a furious rate. Chloride of zinc with opium and starch paste appears to be the most efficient caustic, strips of lint soaked in it being inserted in linear incisions made through the superficial layer, after the skin has been destroyed with nitric acid. After ulceration has set in, the surface must be kept clean and free from putrefaction by means of unirritating antiseptics. Salicylic acid and resorcin have been used as local applications, but they can have no influence upon lymphatic extension. Opium is the only drug that relieves the pain, and for this it must be given in full and increasing doses. Life is not sufficiently prolonged for the evil effects of continued opium-taking to deserve consideration.

DISEASES OF THE MALE BREAST

Inflammation may occur at infancy and occasionally later in life, but it is nearly always periglandular and rarely ends in suppuration. Carcinoma may occur, but other forms of new growth are very seldom met with. The treatment presents nothing special.

EXCISION OF THE BREAST

In cases of carcinoma it should be the rule to remove the whole gland, the nipple, the skin for a wide distance over the tumour, the fascia covering the mammary portion of the pectoral muscle, the lymphatics running up from this to the axilla, and to clear this space out thoroughly and systematically. If the operation is performed before the glands are enlarged, or while they are still small and isolated, there is little difficulty in accomplishing this; if they are already matted together, and to the surrounding structures, the operation becomes at once one of a very serious character. Mitchell Banks, Jacobson, and others. recommend that the pectoral muscles should be divided, completely if necessary; the axillary vein ligatured above and below and cut away, and even more sweeping measures taken, if there is the least suspicion as to the thoroughness of removal. It may be noted that ligature of the vein, even when all the axillary lymphatics are cleared away as well, merely causes transient œdema.

The patient is prepared in the usual manner; the axilla shaved and thoroughly cleansed; the arm moderately abducted from the side; and the rest of the body and the opposite side of the chest well protected with macintoshes. The incision depends to some extent upon the situation of the tumour: an elliptical one, running upwards and outwards to the axilla, is usually recommended; but, in many instances, one shaped like an italic *f* placed horizontally ∽ answers better: it keeps the line of the cicatrix well out of view; it can be carried up readily along the border of the pectoral muscle to the axilla, and, owing to the shape of the breast, it allows a greater amount of skin to be removed without sacrificing immediate apposition of the edges of the wound.

The assistant stands on the opposite side. The lower incision is made first, and a flap of skin and subcutaneous tissue reflected from off the gland until its margin is reached and the edge of the pectoral exposed. The upper incision is then made in the same way; or, if the gland is a small one, the pectoral fascia with the structures lying on it is stripped up at once from the muscle until the opposite border of the breast is reached. As soon as this is done the surgeon, holding the gland in his left hand, divides the skin over the upper hemisphere, and with a few touches of the scalpel sets the whole structure free, except at the upper and outer angle; this part must be carefully preserved, as it contains the majority of the lymphatics and acts as a guide to the axilla.

Hæmorrhage may occur from the incisions in the skin or from the branches of the internal mammary artery coming through the pectoral muscle in a vertical direction. The bleeding points should be covered at once with a sponge, and Spencer Wells' forceps applied. Ligatures are seldom needed.

The surface of the wound must then be carefully examined to see that the whole of the gland has been removed, and that no subjacent fascia is left behind (if the muscle is involved, the fibres should now be taken away); and if the skin will come together with the arm in a position of abduction, the sternal end of the wound may be washed out with a hot solution of corrosive sublimate and united as soon as the hæmorrhage has been stopped. If this is not practicable, it should be carefully covered over with hot sponges, to avoid the chilling effect of exposure.

The arm is then completely abducted; the incision carried along the lower border of the pectoralis major nearly up to the biceps, the fascia divided, and the contents of the axilla dissected out, beginning at the pectoralis major, removing the fascia for some little distance between it and the pectoralis minor, and then working under this until the apex is reached. If there is the least difficulty, there should be no hesitation in dividing these muscles at their insertion as far as may be required. The intercosto-humeral nerves are divided and some branches of the long thoracic and other arteries cut, but there is very little hæmorrhage. If, when approaching the axillary vein, or, what is nearly as important, the end of the subscapular, it is found the glands are extensively adherent, it is better to pass ligatures beneath the vessels and give them to an assistant to hold without tying them. In this way hæmorrhage and the risk of air entering in can be easily avoided. Where structures require dividing high up, pressure-forceps should always be applied first.

The axillary wound is then thoroughly sponged out with hot lotion in the same way; all hæmorrhage stopped; a final examination made to see that the axillary boundaries are really clear, and the arm brought down to the side to allow the edges to be approximated.

Owing to the irregularity of its shape, a thick and wide drainage-tube is always required for the axilla. The sternal end of the incision, on the other hand, unless the patient is very stout, may be left without. Three or four deep sutures of adjustment may be required to take off tension, but it is surprising how a wound that gapes widely when the arm is abducted, falls together as soon as it is placed by the side. If there is not sufficient skin, the surface should be thoroughly cleansed with corrosive sublimate, dusted lightly with iodoform, and covered with a piece of protective cut the exact size.

Afterwards the skin of the arm and the axilla should be thoroughly dried, and the whole space, behind the shoulder, under the arm and along the thorax, carefully packed with loose pieces of some absorbent dressing. The elbow must be supported; the arm fixed to the side; the hand laid on the thorax, and the whole enclosed in a linen binder. As a rule, the wound drains better if the patient lies upon the sound side; but as this may be inconvenient, or cause the injured one to move too much with respiration, this should not be insisted on. The drainage-tube, if there is any oozing, must be cleared the next day; if the wound is really dry, it may be left till the second or third. The patient should on no account be allowed to sit upright, or move the arm until the axillary wound is practically sound.

CHAPTER XXVII

AMPUTATIONS

Amputation of the Limbs

Amputation may be required for injury or disease: and the former may be *primary* (within twenty-four hours); *intermediary* (before suppuration); or *secondary* (after suppuration). But this division is of doubtful value. It is more important to distinguish those cases in which inflammation has not yet occurred from those in which it has already broken out (and the operation is performed with the view of saving the patient from acute septic poisoning); and from those in which the tissues have recovered and are beginning to protect themselves by throwing out a barrier of granulations.

The chief points in planning an amputation are: (1) to sacrifice as little as possible; (2) to provide an ample covering of skin; (3) to arrange the flaps so that their weight shall keep them in position; (4) to make sure there is free exit for any fluid that may accumulate; and (5) to keep the scar away from the line of pressure.

The various methods can be reduced to three: (*a*) the circular; (*b*) the old flap operation, in which all the tissues down to the bone are included; and (*c*) the modified flap operation, in which the covering is formed of skin alone, all the other structures being divided on a level with the end of the bone.

(*a*) *The circular.*—The limb is divided by a succession of circular sweeps: the first through the skin; the second (after the skin has been retracted) through the superficial muscles; the third through the deep ones and the periosteum; and the fourth, when all the tissues are drawn back, through the bone. It is practically limited to the arm; it cannot be used over conical parts (as the skin cannot retract), or where the bone would lie in the centre of the stump, as then it would abut upon the cicatrix. If the limb is injured on one side only, it may be very wasteful; and in cases of disease in which the tissues are hard and brawny, or the skin tied down by adhesions, it is impracticable. Where it can be performed the covering of skin is good, without much muscle, drainage is satisfactory, and the scar very small.

(*b*) *The old flap operation.*—This may be performed either by transfixion, cutting from within outwards, or by dissection, separating the soft tissues from the bones in an upward direction; and the flaps may be antero-posterior, lateral, and equal in length, or one may be much longer than the other. With the exception of one special modification (Teale's amputation), the old operation is seldom performed on any part but the extremities; the flaps are heavy and thick, containing a large amount of muscle; the vessels may easily be slit, or wounded higher up than they are divided; the surface of the wound is very large; and the nerves are contained in the flaps.

In Teale's amputation (which is reserved almost entirely for the lower third of the lower limb), the anterior flap, which contains all the tissues dissected up from the bones, is perfectly square, equal in length and breadth to half the circumference of the limb at the spot at which the bones are to be divided. The posterior flap is of the same breadth, but only one-fourth the length. The bones are divided at the line from which the flaps spring, and the long flap folded round the end, and united behind it to the posterior one, the cut surfaces facing each other. The flaps are measured out and marked down first, and the two lateral incisions made before the transverse ones. The drainage is admirable and the stump left very soon becomes serviceable, if care is taken to keep the larger vessels and nerves in the shorter flap: in any other part of the body it is much too extravagant.

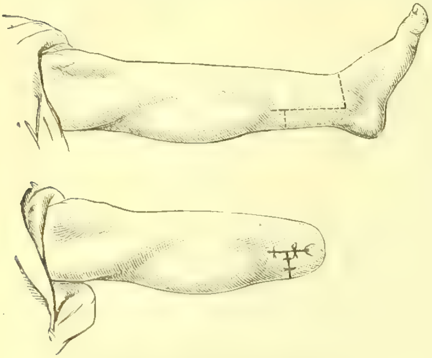
Fig. 481.—Teale's amputation.

(c) *The modified flap operation.*—In this one flap (or sometimes both), is formed from the skin and subcutaneous tissue only; the rest of the structures are divided by a circular sweep at the same level as the bone. It is a method capable of far wider application than any other, and may be modified in a number of different ways.

In Carden's operation, for example (which, though first devised for the knee, may be employed in many other parts), a rounded or semi-oval flap is reflected from the front of the limb, and everything else divided down to the bone, this being sawn through slightly above the plane of the muscles. This leaves an almost flat stump, covered with integument; the edges of the wound are dependent, and the cicatrix lies well out of the way. In other cases (amputation of the forearm, for instance) both flaps may be formed in this way, of equal length or not, according to the amount of tissue available; or lateral flaps may be cut as in the leg, or a kind of hood dissected up, as in Stephen Smith's method.

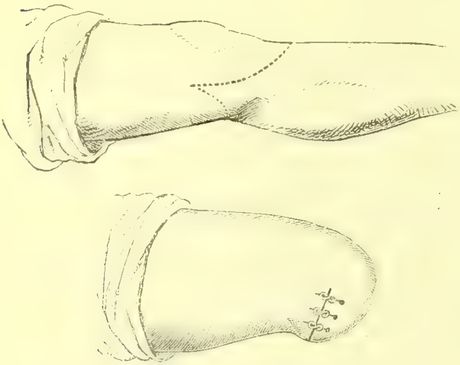
Fig. 482.—Carden's amputation, with short posterior flap.

The position of the surgeon in performing an amputation is always such that he can raise the flap with his left hand, without crossing with the right: usually, therefore, he stands on the right-hand side of the limb. The number of assistants required depends naturally upon the part to be removed: one holds the limb, and afterwards supports the stump in a convenient position; another assists the surgeon in retracting the flaps, sponging, and tying vessels; and a third may be required to control the main artery. Where it is possible the patient should be carefully prepared; the bowels opened; the urine examined; the pulse, respiration, and temperature noted; and the limb thoroughly cleansed, and if necessary shaved. The last meal should be a light one and three hours at least before the operation. The anæsthetic of course requires a special assistant.

During the operation the bed should be thoroughly warmed, and hot bottles, pillows, &c., arranged, so that the patient may be placed in a comfortable position at once, with the stump slightly raised and secured against any accidental movement or spasmodic contraction of the muscles. Unless the patient is thoroughly covered up, the loss of heat during an operation (especially under ether) adds seriously to the shock.

SPECIAL AMPUTATIONS

AMPUTATION AT THE SHOULDER-JOINT

Spence's operation is the most useful, as in case of doubt it enables the head of the bone to be examined with the least disturbance. The subclavian may be compressed by an assistant; but as this is often a difficult proceeding, the vessels may be caught in the flap by the surgeon or his assistant, or isolated and secured before division. The position of the patient is semirecumbent, with the shoulder projecting over the edge of the table and the arm moderately abducted.

The incision runs from just outside the coracoid process to the insertion of the pectoralis major, which should be divided. If amputation is to be performed, it is then carried horizontally across the outer side of the arm to the posterior border of the axilla, dividing the deltoid. The inner incision, from the same point to join the termination of the outer, may be marked out now, but it must not be deeper than the skin. The outer flap is raised; the capsule, the tendons attached to the tuberosities, and the long tendon of the biceps divided by cutting on to the bone; the limb disarticulated and the soft structures on the inner side cut through, the artery being either secured by an assistant, or exposed and ligatured before division. The axillary and the anterior circumflex are the only vessels necessarily cut.

In cases of malignant disease, in which it is wished to retain as little of the soft structures as possible, skin flaps may be used instead. Lateral ones are marked out: (*a*) by an incision beginning in the middle of the axilla, passing down nearly as low as the insertion of the deltoid on the outer side of the arm, and then curving upwards to end just outside and below the coracoid process; and (*b*) by a second beginning and ending at the same points, only passing a sufficient distance down the inner side of the arm. Or a racquet-shaped incision may be employed, starting from the same point near the coracoid, and running first down the outer side of the arm and then circularly round it. In either case the skin is dissected up, the soft parts divided and the vessels secured as before. In this method the posterior circumflex is usually divided as well as the anterior.

Other methods are by transfixion from behind forwards (or *vice versâ*, according to the side) forming a great external flap of the deltoid and the skin covering it; and Furneaux Jordan's—circular through the arm below, and then, after the vessels are secured, dissecting out the upper end of the humerus.

AMPUTATION OF THE ARM

The circular method usually gives an excellent result: but skin flaps with circular division of the muscles, or one of these in front, and a short transfixion flap behind, may be adopted instead. In this amputation, as in all others through the shaft of a bone, the periosteum should be divided some little distance below the bone, so that it may invest and adhere to the face of the section.

AMPUTATION OF THE FOREARM

Skin flaps with circular division of the muscles should be adopted wherever it is possible; but the circular operation, Teale's method, and transfixion (for one flap) may be employed. Care should be taken to supinate the limb while the bones are being sawn, to ensure their being parallel.

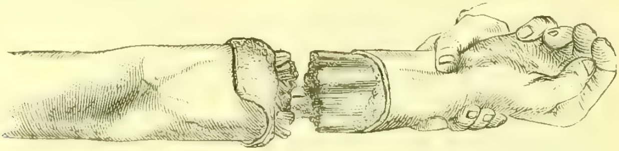

FIG. 483.—Amputation of forearm by mixed method.

Disarticulation at the elbow and wrist does not require special mention.

AMPUTATION OF THE THUMB

This may be performed either with a racquet-shaped incision or with a palmar flap formed by transfixion. In the former case the thumb is held in the extended position; the point of the knife introduced on the dorsal surface of the base of the metacarpal bone, and the incision carried down the bone, nearly to the phalangeal articulation; then it winds around the bone, descending on the ulnar side (in the case of the left hand) and ascending on the radial until it joins the dorsal incision again. The skin is then dissected back, the carpo-metacarpal articulation opened, and the soft tissues divided, taking especial care of the radial artery. In the latter the thumb is slightly abducted, and a flap cut by transfixion from the muscles of the ball. If the left hand is in question, the point is introduced on the palmar side of the carpal joint, carried obliquely over the dorsal surface of the metacarpal bone to the ulnar side of the phalangeal joint, and thrust through the ball of the thumb until its point emerges through the original puncture. In cutting out it is advisable to keep close to the bone, but care must be taken not to lock the blade against the sesamoids. On the right hand the flap is cut first and its two extremities joined over the dorsum.

AMPUTATIONS OF THE FINGERS

It must be remembered that in all these joints the bone that projects on the dorsal surface is the proximal one; and that, on the palmar surface, although the fold of the skin corresponds fairly well to the first inter-phalangeal joint, this is not the case either with the one above or the one below: the circle formed by the skin (when the fingers are flexed) is smaller than that formed by the bones, and consequently the distance between the folds is less than that between the joints; the nearest of the three is the thickness of the metacarpal bone below the articulation; the middle one corresponds to it; and the farthest is the thickness of the phalanx above.

(*a*) *Amputation at the metacarpo-phalangeal joint.*—A racquet-shaped incision is the best, commencing on the neck of the metacarpal, running straight down on to the phalanx, and then winding round the finger below the web. It should divide the extensor tendon at once, and pass right down to the bones. Afterwards the lateral ligaments and a few other structures require division. In the case of the index and little fingers, the incision should be made at the side, as it is less conspicuous. Where strength is required the head of the metacarpal should be left, but if it is wished to minimise the deformity at all cost, it may be removed obliquely with bone-forceps.

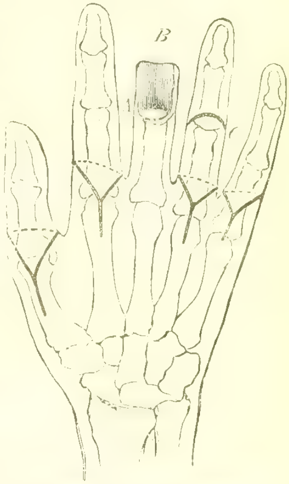

FIG. 484.—Outline diagram for amputation of the thumb and fingers.

(*b*) *Interphalangeal amputation.*—This is usually performed with a single palmar flap; but single dorsal, lateral ones, or equal dorsal and palmar, may be selected instead.

When a long palmar flap is chosen, the finger is bent to a right angle, and the knife (which should be long and very narrow) drawn across the front of the joint, so as to open it and divide the extensor tendon at one sweep. The lateral ligaments are then divided, and the knife insinuated behind the distal phalanx, and, following its palmar surface, made to cut a long square-shaped flap from the under portion.

It is usually recommended not to amputate through the proximal phalangeal joint, or through the proximal phalanx itself; but, as Jacobson points out, this rule should not be followed in the case of the index or little fingers, when all the fingers are amputated, or when the patient prefers to have it left. If the flexor tendons are stitched to the theca, the periosteum or even to the skin, the stump follows all the movements of the other fingers.

AMPUTATION AT THE HIP-JOINT

The older operations (anteroposterior transfixion flaps, and lateral skin or transfixion ones) have given place to Furneaux Jordan's method: the shock is very much less; the risk of hæmorrhage not so great; the wound is as far away from the anus as it can be; and the stump is sufficiently long and well nourished to carry an artificial limb, at any rate for a short time.

The patient is brought well down to the edge of the table, and the vessels controlled either by Lister's tourniquet (p. 218), Davy's rectal lever (p. 295), or Jordan Lloyd's elastic strap. This consists of a piece of stout rubber tubing carried obliquely from high up in the groin, across the hip (one end above, the other beneath), to the middle of the iliac crest, where it is held by an assistant. Either a pad, or a properly shaped block of wood grooved on its upper surface to prevent the strap slipping from off it, is fitted over the vessels at Poupart's ligament. A circular amputation is then performed through the lower third of the thigh, the skin, fascia, and muscles being divided down to the bone, and the vessels secured. As soon as this is done, the wound is packed with sponges wrung out of hot corrosive sublimate lotion, and an incision made along the outer side of the limb, from the circular wound to a spot midway between the trochanter and the iliac crest; the soft parts (including the periosteum, if it is thought advisable) are stripped off the bone; the joint opened by cutting on to the neck, and the femur disarticulated by the assistant. It is doubtful if any bone is ever reproduced, but there is no question that the preservation of the periosteum adds to the stability and nutrition of the stump.

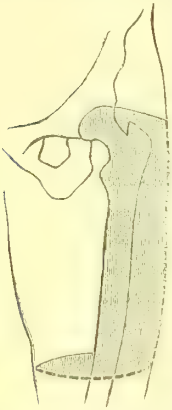

FIG. 485.—Furneaux Jordan's method of amputation at the hip-joint.

In the operation by lateral flaps, the surgeon stands on the right-hand side, and marks out the incisions successively, starting from the tuber ischii behind, running down a hand's-breadth below the trochanter (or a corresponding distance on the inner side of the limb), and ending in the centre of the groin, immediately outside the femoral vessels. The external flap should be dissected up first; the vessels secured, and the joint opened; and then the tissues on the inner side of the limb, this part being finished either by dissection or transfixion. Disarticulation is performed last.

In the anteroposterior method, a flap five inches long is formed by transfixion from the tissues of Scarpa's triangle. The knife enters midway between the anterior superior spine and the great trochanter, passes across the front of the joint (opening the capsule, if possible), and avoiding the obturator foramen, emerges close to the tuberosity of the ischium. On the left limb it takes the reverse course. One assistant holds the limb slightly flexed, while a second, as the knife cuts out the flap, follows it with his fingers and seizes and compresses the vessels as they are divided. The flap is drawn up as far as possible; the first assistant extends and rotates the limb outwards, to put the capsule on the stretch; the joint is opened freely, an incision made round the great trochanter, and the head of the bone dislocated by over-extension and abduction. As soon as this is accomplished, the ligamentum teres is cut, and while the assistant raises the limb and draws it away from the body, the surgeon places the knife transversely in the wound, behind the head of the bone, and cuts a short posterior flap. The vessels on the front of the limb can be controlled in this operation, but unless measures are taken to secure the internal or common iliac, the hæmorrhage from those behind, and from the cut surface of the muscles, is very severe.

AMPUTATION THROUGH THE FEMUR

(*a*) In amputations through the shaft, the mixed method (an anterior skin flap with a shorter posterior one by transfixion) answers so well that any other is seldom needed. Care must be taken not to slit or prick the artery as it is passing out of Hunter's canal, and in arranging the dressings it must be remembered that, owing to the rotation of the thigh, the flaps very soon assume a lateral position.

(*b*) Amputation through the condyles may be performed according either to Carden's or Stokes' method. The section of the bone in the former runs through the base of the condyles, and the anterior flap passes across the limb midway between the apex of the patella and the tubercle of the tibia; in the latter, the bone is divided above the condyles (supracondyloid), and the anterior flap reaches down to the tubercle, the increased length being required by the patella, the sawn surface of which is removed, so that it may face and become adherent to the cancellous tissue of the femur. They are both far superior to amputation through the thigh, owing to their enabling the pressure to be borne (in part at least) on the face of the stump and their preserving the insertion of the adductor, and, in Stokes', the extensor muscles. Gritti's amputation is similar to Stokes', but the bone is divided half-an-inch lower, and the patella does not fit so well. In Carden's operation there is no posterior flap at all; in Stokes' it is nearly as long as the anterior, and is cut either by dissection or transfixion, according to the bulk of the limb.

AMPUTATION THROUGH THE KNEE-JOINT

Stephen Smith's is the most satisfactory, as anteroposterior flaps require to be of such length (both on account of the depth of the femur and the tendency of the posterior one to retract) that there is always danger of sloughing. The stump (which includes the patella) is of excellent shape, and well calculated to bear weight.

The incision commences one inch below the tubercle of the tibia, runs curving downwards (with a wider sweep on the inner side than the outer, owing to the greater depth of the inner condyle), over the side of the leg to the middle line behind, and then upwards for about three inches and a half to the centre of the popliteal space. A similar flap is shaped from the other side; the skin and fascia are reflected upwards; the ligamentum patellæ divided; the joint opened, and the soft part separated by a circular sweep round the limb. It is recommended to leave the semilunar cartilages attached to the femur, as they prevent retraction to some extent. This operation does not enable the suprapatellar pouch to be dealt with in any way, and accordingly is better suited to cases of injury than of disease.

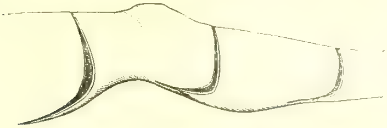

FIG. 486.—Stephen Smith's method of amputating.

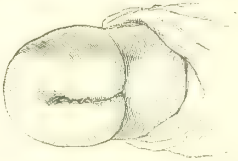

FIG. 487.—Posterior aspect of stump after Stephen Smith's amputation at knee-joint, showing cicatrix.

AMPUTATION THROUGH THE LEG

In the upper half, Stephen Smith's method, or that in which lateral flaps are combined with circular division of all the subjacent tissues, gives the best result; but, particularly in cases of injury, it may be advisable to adopt others. In sawing the bones, care must be taken to divide the fibula before the tibia, and to remove the sharp angle left by the crest of the latter, for fear of its causing undue pressure.

The lower half of the leg is the favourite situation for Teale's amputation.

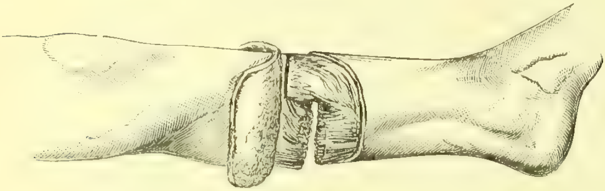

FIG. 488.—Amputation of the leg by the mixed method.

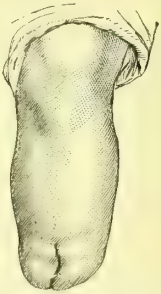

FIG. 489.—Stump after an amputation of the leg by the mixed method.

AMPUTATIONS AT THE ANKLE-JOINT

The most important are those known by the names of Syme, Roux, and Pirogoff.

Syme's.—The whole of the foot is removed with the malleoli, and the stump covered with a flap formed from the heel. The incisions are : (1) from the tip of the external malleolus across the front of the ankle-joint (very slightly convex downwards), to the corresponding point (half an inch below and behind the internal malleolus) on the inner side ; and (2) between the same points across the sole of the foot, slanting slightly backwards on to the point of the heel. On the left foot the incisions are begun on the inner side.

The ankle is supported on the edge of a firm cushion at a suitable height and the fore part of the foot held by the operator's left hand in a position of extreme dorsal flexion. The plantar incision is made first, carrying it right down to the bone (the knife is short and stout) ; then, the grasp being altered so as to place the foot in extreme plantar flexion, the dorsal one, taking care not to cut on to the astragalus (or still more the joint in front of it), but to open the ankle-joint at once. The foot is now depressed more and more ; the lateral ligaments divided ; the upper surface of the os calcis exposed, and then the tendo Achillis. This is separated from its insertion with the point of the knife, taking care not to button-hole or score the flap, and with a few touches the foot is detached. The tendons must be shortened with scissors, and the malleoli removed ; but, unless the lower end of the tibia is diseased, there is no need to remove the cartilage. The arteries divided are the dorsalis pedis and the two plantars. It is of consequence not to cut the posterior tibial before its division, as the nutrition of the flap depends mainly upon the calcanean branches.

Roux's.—In this the flap is taken from the inner side. The incision forms an irregular oval, commencing at the apex of the external malleolus, running across the front of the ankle as far as the scaphoid on the inner side, then sweeping round to gain the middle line of the sole, passing up the posterior border of the tendo Achillis, and ending where it began.

Pirogoff's.—The posterior portion of the os calcis is sawn off and brought face to face with the cut surface of the tibia. The limb is longer than after a Syme's, and the stump wastes less, but it is not suited to cases in which the bones are diseased.

The position of the foot and the incisions are almost the same as in a Syme's, but the plantar one, instead of sloping backwards passes transversely across the sole from point to point, or, if the arch of the foot is very high, may even slant a little forwards. The amputation may either be performed in the same order as a Syme's, the os calcis being sawn through from above instead of being detached, or the bone may be divided through the plantar incision as soon as this is made, the chief advantage being that it is more easily held. In either case the line of section should run from above downwards and forwards so as to secure a large surface and prevent tension upon the tendo Achillis. Pirrie advocates sawing the tibia through in the same way from the dorsal incision, without opening the joint, a few tendinous and ligamentous bands only requiring division afterwards. Apposition of the bony surfaces is best secured by one or two chromic gut sutures passed through them.

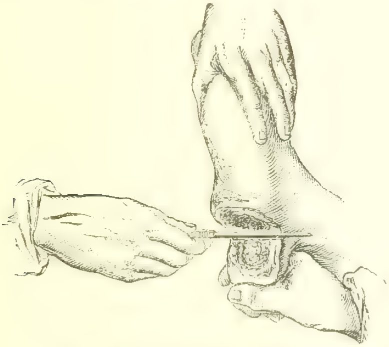

Fig. 490.—Pirogoff's amputation. Heel flap with os calcis.

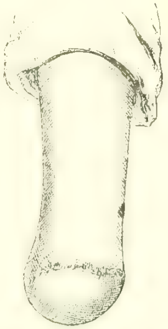

Fig. 491.— Stump after Pirogoff's amputation.

Amputations through the Foot

The most important are Chopart's, Tripier's, the subastragalar operation, and Hey's or Lisfranc's. Formal operations, however, are seldom performed ; in cases of disease in which local measures have failed, it is rarely possible to leave much of the tarsus ; and after injury it is better simply to prevent decomposition and wait until it is seen how far the tissues can repair the damage of themselves. Following this principle, on one occasion, in which the contents of a gun had blown a hole through a man's foot, I succeeded so well that within six months the patient could walk three or four miles and ascend ladders without inconvenience.

Chopart's amputation through the mid-tarsal joint.—The foot is supported as in Syme's operation, and the anterior part held in the left hand so that it may be placed in extreme plantar or dorsal flexion as required. The tubercle of the scaphoid and the corresponding point on the opposite side (midway between the external malleolus and the base of the fifth metatarsal) are defined, and the plantar flap marked out first. It extends from behind the tuberosity of the fifth metatarsal along the outer side of the foot to the ball of the toe, then obliquely forwards across the sole (so that it may be longer on the inner side than the outer), and back along the inner border to the scaphoid. The dorsal incision may be made next, but, as in disarticulating there is some risk of wounding the structures in the sole, it is better to dissect the plantar flap back from off the bones (taking care to include the artery) and have it held well out of the way. The two ends of the plantar incision are then connected over the dorsum by a second, slightly convex forwards, the extensor tendons and ligaments divided, and disarticulation completed.

The stump left by this operation is in many cases exceedingly good; but sometimes it tilts so far forwards that the cicatrix presses against the ground. It is probable (as the os calcis and astragalus, having lost the support of the anterior pillar of the arch of the foot, must always tilt downwards in this way) that this arises from the plantar flap being too short; or it may result from unopposed contraction of the gastrocnemius. It can usually be prevented by dividing the tendo Achillis and suturing the extensor tendons in front into the periosteum or the cut ends of the ligaments.

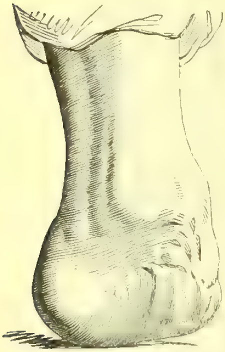

Fig. 492.—Stump left after Chopart's amputation.

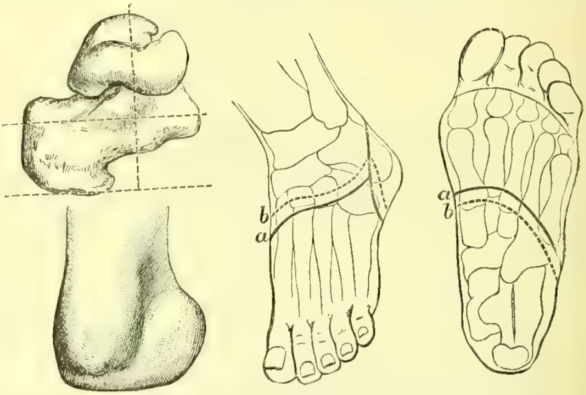

Fig. 493.—Tripier's amputation of the foot. (*a*) Section through the skin; (*b*) through the soft parts.

Tripier's.—The under part of the os calcis is sawn off horizontally just below the sustentaculum tali (having as far as possible preserved the periosteum) in order to leave a surface at right-angles to the axis of the tibia.

The incision (through the skin only) begins at the outer edge of the tendo Achillis, on a level with the external malleolus, and runs downwards and forwards below that projection to the base of the metatarsal bone of the fifth toe. Thence it passes slightly convex forwards, across the sole, until it reaches the inner side of the foot, well in front of the projection caused by the base of the first metatarsal; and winding upwards over the inner border, continues across the dorsum until it joins the first over the calcaneo-cuboid articulation. As soon as the skin has retracted, the soft parts are divided down to the bones; disarticulation effected at the mid-tarsal joint; the periosteum detached from the under surface of the os calcis and the bone sawn through, from behind and within, forwards and outwards.

The subastragalar operation.—The incision for this is nearly the same, but it commences an inch below the external malleolus (instead of at the tendo Achillis) and does not run quite so far forwards on the sole of the foot. The soft parts must be dissected off the under surface of the cuboid and os calcis; the interosseous ligament between the latter bone and the astragalus divided from in front (space can be obtained by depressing the toes) and then the tissues on the inner side and the tendo Achillis. The operation is one seldom performed in England, and opinions as to its merits are undecided.

Hey's and Lisfranc's.—Amputation of the toes at the tarso-metatarsal articulation : in the former the saw was used to a limited extent (in one of the original operations the internal cuneiform was divided) ; in the latter the disarticulation is complete.

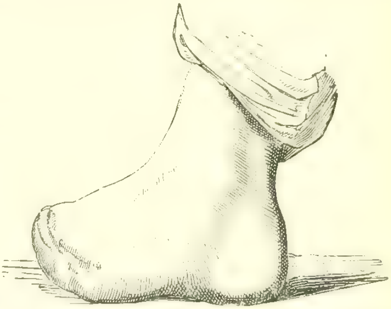

FIG. 494.—Stump after Hey's amputation.

The operation is performed in the same way and by the same incision as Chopart's, with the exception that instead of the scaphoid and the calcaneo-cuboid articulation being used as landmarks, the bases of the first and fifth metatarsals are taken. A plantar flap running across the heads of the metatarsals and longer on the inner side than the outer, is marked out and dissected back ; the posterior ends of the lateral incisions are joined by one across the dorsum, and the toes being depressed as far as possible, the dorsal ligaments of the three outer and the inner metatarsal articulations divided. The articulation of the second, which is placed in a recess posterior to the others, must either be dealt with by itself, using the point of the knife lightly, or the base of the bone sawn off.

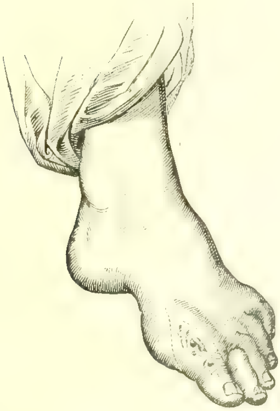

FIG. 495.—Incision for amputation of great toe.

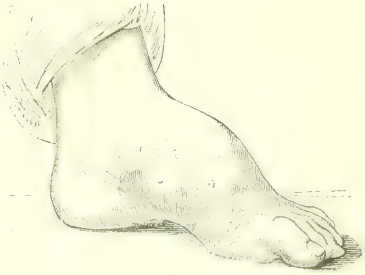

FIG. 496.—Incision for removal of the metatarsal bone of the great toe.

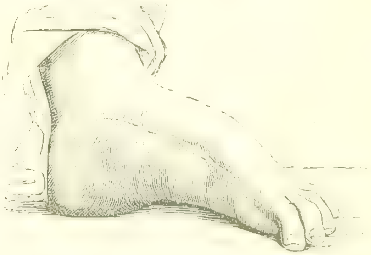

FIG. 497.—Stump after the removal of metatarsal bone.

AMPUTATION OF THE TOES

The incisions are the same as in the case of the fingers, but on no account may the part of the sole that receives the pressure of the foot be interfered with. The tendon-sheaths should be secured by sutures, as otherwise they form open vertical drains (when the patient is lying in bed), conducting into the sole of the foot any discharge that does not escape at once.

Amputation of the great toe is performed by means of a racquet-shaped incision: the head of the metatarsal should always be preserved if possible; and when it is necessary to remove this bone (which may be done through a similar incision commenced farther back), the base, with the insertion of the peroneus longus, should be left intact.

DISEASES OF STUMPS

The tissues in a stump always waste to some extent; the bones atrophy; the muscular fibres disappear; the vessels contract and the temperature falls. The skin, however, should retain its natural texture and colour; there should be no tender spot; the scar should be well out of the way of pressure and not adherent to the bone; and there should be a good pad of fatty and fibrous tissue around the end.

Conical stump.—A stump may become conical either from a deficiency in the soft parts, or from growth of the bone. The former usually arises from the flaps having been originally too short; from their having retracted, owing to the amount of muscle contained in them; or from their having sloughed. The latter seldom occurs except in children, and in them especially in the leg. The treatment consists either in excising the end of the bone, slitting up one side of the stump to render it more accessible, or re-amputation, according to the condition of the part.

Necrosis.—This may arise from the periosteum having been stripped off too far, so that the end of the bone is deprived of its blood-supply; or from inflammation. In the latter case the extent depends upon the severity of the attack—there may be merely a scale from the end of the bone, or a long tubular sequestrum.

Aneurysm has been known to develop, and one or two cases of *arterio-venous aneurysm* are on record.

Neuralgia (p. 174) may arise from a nerve being involved in the cicatrix, so that it is dragged upon by the scar-tissue, or from the end of one becoming bulbous. In the latter case there appears to be a growth of nerve-fibres, but the bulk of the mass is made up of connective tissue (pp. 127 and 330). The pain when one of these is touched is described as like an electric shock, shooting down the distribution of the nerve. The only treatment is excision, and usually it succeeds at once.

There is, however, another variety of neuralgia very much more serious in character. The stump is red and glazed; to the touch it is icy-cold, but the patient complains of an intense ceaseless burning; no one part is worse than the other, the whole of the limb for some distance is exquisitely tender and the seat of agonising pain. It is not known to what this is due: nerve-section and nerve-stretching have only a transient influence on it, and I have known it return again and again in the stump after amputation had been performed in the hope of securing relief.

Muscular spasm of a chronic character is sometimes met with. Usually it is due to reflex irritation, but in many cases no cause can be found. Relief, when only a single muscle is affected, can be obtained by tenotomy, but unless the source of irritation is removed the spasms are very likely to recur.

In addition, stumps are liable to be attacked by epithelioma, cheloid, and the other affections of scars; and in cases of amputation for disease, if the line of section is not sufficiently high, recurrence takes place in the stump.

CHAPTER XXVIII

ANÆSTHETICS

1. LOCAL ANÆSTHESIA

FINELY-powdered ice and salt or ether-spray causes numbness of the skin, but the effect is limited to the surface; it cannot be kept up without the risk of sloughing; and the pain of thawing is almost, if not quite, as severe.

Hydrochlorate of cocaine sprayed or painted over a mucous surface or a recent wound will ensure local anæsthesia for a quarter of an hour or more; but it is of no use on unbroken skin or where the tissues are inflamed. The ordinary strength is gr. xx or ʒss to the ounce, and the solution should always be fresh as it soon decomposes. It may also be employed hypodermically, a grain or a grain and a half being injected at a time; but very serious symptoms—syncope, delirium, unconsciousness, and even collapse—have been known to follow. Whether this is due to the products of decomposition of the drug or to personal susceptibility is uncertain. Capillary oozing is always severe when cocaine is employed.

2. GENERAL ANÆSTHESIA

Nitrous oxide gas, chloroform, ether, bichloride of methylene, and a mixture of equal parts of alcohol, ether and chloroform (known as the A.C.E. mixture) are the chief agents used. The apparatus and the method vary in each case, but in all alike the clothing should be loosened; false teeth removed; and the patient placed in a suitable position (usually recumbent, with the head slightly raised and turned to one side). An anæsthetic should not be given for some hours after a meal; if there is a feeling of faintness or the pulse is weak, a small quantity of brandy may be given by the mouth or injected into the rectum.

Nitrous oxide gas is especially useful for short operations (the anæsthesia lasting about a minute) and as a preliminary to ether. It is practically free from danger, and is seldom attended with sickness or headache.

The gas passes from a reservoir through a face-piece, contrived to exclude air thoroughly. After a few inspirations the face becomes dusky and the breathing deeper; then towards the end of the minute the eyes grow prominent, the pupils dilate, the lips become blue and the respiration stertorous: at this stage anæsthesia is complete; if the administration is continued convulsive movements begin. The insensibility may be prolonged without any unpleasant effect by giving a small quantity of ether with the gas after the first few breaths.

Ether is always given through an inhaler. In Clover's the same air is breathed over and over again, and the amount of vapour added is regulated by an index. In Ormsby's an ounce is poured upon a sponge at the beginning, and the proportion of fresh air varied.

The vapour must be admitted very gradually at first, as it is so unpleasant that many patients can hardly tolerate it; and if possible preliminary anæsthesia should be induced with gas. As the amount is increased the face becomes congested, a period of excitement with violent struggling (especially in men accustomed to drink) follows; and then, comparatively suddenly, the muscles relax, and the breathing becomes stertorous. If Clover's inhaler is used a breath of fresh air should be allowed every half-minute until anæsthesia is complete; then the interruptions should be more and more frequent until, when the administration has lasted some time, the inhaler is only applied occasionally.

As a general anæsthetic, ether is much safer than chloroform, and unless contra-indicated should always be used in preference. Unfortunately it is more unpleasant, leaving a severe headache, and the smell hangs about for days. It is not suited to operations about the mouth, nose, or eyes; to operations upon the brain or large vessels; or to cases of bronchitis, empyema, phthisis, or extreme abdominal distension. Women and children take it very well; drunkards can scarcely be got under its influence, unless they are partially intoxicated already—then the transition from one stage to the other is very easy. Care must be taken not to bring it near a naked light.

Chloroform.—All that is required is a drop-bottle and a fold of lint doubled. A few drops are sprinkled on first, then a few more, gradually increasing the quantity; and the lint is turned over so that the moistened surface may face the mouth; it must not touch it or the skin, for fear of causing blisters. The pulse and respiration (not the movements of the chest, but the actual influx and efflux of air) must be watched from the first. Except in children, a period of excitement nearly always precedes that of unconsciousness; and sometimes in men there is severe struggling, but unless the respiratory muscles remain rigidly contracted, there is no need to suspend the administration. The pulse may be increased in frequency during the struggling stage, and the pupil dilated; as it passes off the respiration becomes slow and deep; the pulse falls to its normal rate, and the pupil contracts, still retaining its power of reacting to light. Snoring, and the loss of the conjunctival reflex, are signs that the patient is fully anæsthetised, and that the administration may be suspended for a breath or two and then carried on more gradually.

Chloroform is preferable to ether for all operations about the mouth and nose (Junker's apparatus, in which air is driven through the liquid by means of a ball syringe, is especially suited to these); for operations upon the brain and eye; in infants and old people; in cases in which the breathing is embarrassed, and in midwifery. In all other conditions ether is more safe: it is true that deaths have occurred during its administration, but the proportion is not nearly so large as in the case of chloroform, and the patients have almost all been suffering from some grave internal disorder.

Chloroform acts both upon the heart and the respiratory centre. Syncope may occur with the first few breaths, before the operation; or with the first incision (it has been suggested that in these cases it is really due to shock, the patient not being sufficiently anæsthetised). Spasm of the respiratory muscles may prove fatal during the struggling stage. Later, even after the administration is over, the respiration or the heart may stop, the latter usually giving the first indication, though the former is the first to cease altogether. For this reason it is absolutely essential to watch both the pulse and the breathing throughout.

An injection of morphia before the chloroform is given enables anæsthesia to be produced much more rapidly and without any struggling, but it very greatly increases the danger of syncope. Ether, on the other hand, diminishes the risk, and in many cases in which it cannot be given during the operation, it is advisable to anæsthetise the patient with it, and when the blood is well saturated substitute chloroform.

The A.C.E. mixture may be used instead of chloroform in many cases, but care must be taken that the mixture is fresh and that very small quantities are given at a time. The liquids evaporate with different degrees of rapidity, and if a large quantity is poured on to an inhaler at once, nearly the whole of one may come off before the others are appreciably affected.

Bichloride of methylene is best given with Junker's apparatus. Its composition is somewhat doubtful; probably it is only a mixture, and as it is affected by exposure to air, it should always be freshly opened. With women it succeeds fairly well, and there is very little tendency to sickness afterwards; but it is difficult to secure a sufficient degree of anæsthesia in any patient accustomed to alcohol.

Special symptoms.—*Struggling* and *excitement* are particularly severe in the case of ether. At the beginning they are due to the fearful sensation of choking caused by the vapour being too concentrated, and, making allowance for this, are under the patient's control. Later they are involuntary. Epileptiform convulsions may occur, but the chief danger is the sudden inhalation of an excessive amount of vapour. A considerable degree of excitement is sometimes met with during the recovery from ether, especially if the anæsthesia has not been of long duration.

Vomiting is almost sure to occur if the stomach is full, and may prove serious. It may happen at the beginning, but it usually takes place later, or during recovery. Pallor of the face and lips, failure of the pulse, and retching precede it, and the administration should always be stopped until the stomach is emptied. No food should be allowed for some hours after an anæsthetic, merely a few small fragments of ice, if the thirst is great, and for the first twenty-four hours everything should be cold. If vomiting persists, bismuth and morphia may be given and a mustard plaster applied to the epigastrium; but usually it is better to leave the stomach altogether alone and feed the patient by means of enemata. I have known minim doses of vinum antimoniale every quarter of an hour succeed in a case that seemed likely to prove serious.

Dyspnœa may arise from respiratory spasm during the struggling, but a much more common cause is the falling back of the tongue and the collapse of the upper aperture of the larynx. When this is slight it causes a peculiar stertor, which can be relieved by pressing the point of the chin forwards and upwards, or, if this does not succeed, by seizing the tongue with a broad pair of forceps and drawing it well out of the mouth. The condition is easily relieved if the cause is noticed, but as the thorax continues to move naturally there is great danger of overlooking the fact that no air is entering.

Heart-failure is an accident peculiar to chloroform. As already mentioned, it may occur with the first few breaths, or during and even after the administration; and it may be accompanied or not by failure of respiration. At the first suspicion of weakening of the pulse the anæsthetic should be stopped and every endeavour made to clear the lungs of the vapour that fills them ; the tongue should be drawn forwards ; if the breathing is not deep and thorough artificial respiration should be commenced, and if there is the least impediment to the entry of air, tracheotomy should be performed. A subcutaneous injection of ether or brandy may be of some service, and inversion of the patient, so that the head receives a full supply of blood, is undoubtedly of use ; but neither galvanism nor nitrite of amyl has been proved to be of any practical benefit.

INDEX

A

Abbe, trephining spine, 813
Abdominal aneurysm, 273 ; Loreta's case, 263
  aorta, ligature of, 293 ; compression of, 294
  distension in strangulation, 1059
  section in ectopic gestation, 1324
Abdomen, injuries of, 1002 ; wounds, 1004
Abduction in hip-disease, 663
Abductors of larynx, paralysis of, 934
Abnormalities. *See* Malformations
Abnormal mobility in fracture, 394
Abscess, 24 ; alveolar, 880 ; antral, 880 ; of bone, 496, 499 ; of breast, 1355 ; cerebellar, 750, 753 ; cerebral, 748, 755 ; chronic, 1358 ; of chest wall, 993, 995 ; hæmorrhage into, 35 ; of hip, 666, 675 ; ischiorectal, 1122 ; of liver, 1093 ; lumbar, 794 ; mediastinal, 993 ; perineal, 1293 ; periurethral, 1269 ; psoas, 794, 799 ; pyæmic, 58 ; residual, 404 ; retropharyngeal, 793, 799 ; sacro-iliac, 678 ; spinal, 792, 799 ; subcranial, 743 ; subdural, 753 ; tubercular, 657 ; urinary, 1293 ; varieties of, 28
Absorbents, diseases of, 302
Absorbent wool, 163
Absorption of bone, 492 ; callus, 383, 386 ; cartilage, 610 ; of neck of femur, 464, 639, 660 ; sequestra, 493 ; of thrombi, 241
Acarus scabiei, 202
Accessory thyroids, 969
Accidents, railway, amputation in, 411
  from taxis, 1025
Accommodation, loss of, in diphtheria, 841
A.C.E. mixture, 1385
Acetabulum, disease of, 660 ; fracture of, 453 ; and neck of femur, 463
Achorion of favus, 204
Acids, application of, in piles, 1110
Acne, 194 ; on face, 855 ; in syphilis, 84
Aconite in inflammation, 16 ; in aneurysm, 257
Acquired talipes, 361
Acromion, fracture of, 429
Actinomycosis, 72
Active clot, 251
Acupressure, 221, 242
Acupuncture in aneurysm, 264 ; for hydrocele, 1319 ; in neuritis, 325
Acute arthritis of infants, 511, 625
  epiphysitis, 502, 511, 625
  necrosis, 501
  progressive myositis, 337
  rickets, 532
  suppurative osteomyelitis, 501, 548, 625
Adams, 345
Addison's cheloid, 174
Adduction in hip-disease, 663
Adductor longus, rupture of, 332
Adductors of larynx, paralysis of, 934
Adenitis, 304
Adenoma, 134 ; of breast, 1360 ; mouth, 884 ; testis, 1311
Adenosarcoma, 131
Adhesions in intussusception, 1054 ; as a cause for strangulation, 1050 ; in hernia, 1030 ; in ovariotomy, 1333
Age as a cause for fracture, 377 ; influence of, in repair, 388 ; in lithotrity, 1215 ; in lithotomy, 1223
Agnew, 353
Air, entry of, into veins, 230 ; exclusion of, in burns, 180
Air-passages, wounds of, 938 ; foreign bodies in, 942
Albumen in urine, 1176
Albuminoid degeneration, 35
Albumose in anthrax, 68
Alcohol as a cause of neuritis, 324
Alcoholic coma and concussion, 726
Allingham, formation of spur in colotomy, 1084, speculum, 1103
Alopecia, areata, 206 ; syphilitic, 86
Alternating strabismus, 817
Alveolar abscess, 880 ; sarcoma, 130
Amastia, 1352
Amaurosis, tobacco, 837
Ammonia in inflammation, 16 ; erysipelas, 65 ; shock, 144
Amputation, 1371 ; in aneurysm, 264 ; of arm, 1374 ; in arthritis, 629 ; of breast, 1369 ; in burns, 180 ; Carden's, 1372, 1377 ; of cervix uteri, 1346 ; Chopart's,

1379; in dislocations, 560; of foot, 1379; of forearm, 1374; in fractures, 412, 472; in frost-bite, 50; Furneaux-Jordan's, 1374, 1375; in gangrene, 49; Gritti's, 1377; for hæmorrhage, 225; for hip-disease, 676; of the hand, 1374; Hey's, 1381; at the hip, 1375; in inflammation, 56; at the knee, 1377; of the leg, 1377; Lisfranc's, 1381; of the penis, 1299; Pirogoff's, 1378; Roux', 1378; at the shoulder, 1373; Stephen Smith's, 1377; Spence's, 1373; Stokes', 1377; subastragalar, 1380; Syme's, 1378; Teale's, 1372; Tripier's, 1380
Amussat's operation, 1081
Anæmia in syphilis, 84
Anæsthesia of larynx, 933; after nerve-section, 316; in spinal injury, 776
Anæsthetic leprosy, 104
Anæsthetics, 1383; in fractures, 405; in intestinal strangulation, 1058; in ophthalmic work, 845; in taxis, 1024
Anastomosis of nerves, 316; intestinal, 1090
Anatomical tubercle, 74
Anatomy of hernia, 1011
Anchylosis, 691; in caries of spine, 790; after fractures, 403; of hip, 676; of jaw, 882; after nerve-section, 317
Anel's method of ligature, 259
Aneurysm, 249; by anastomosis, 125, 232; arteriovenous, 228, 845; of aorta, 265; and atheroma, 238, 249; of axillary, 273; cirsoid, 232; of carotid, 268; of femoral, 277; of glutæal, 276; of innominate, 266; of internal iliac, 276; needles, 281; non-pulsating, 256; of orbit, 270; of popliteal, 278; of pudic, 276; at root of neck, 265; sciatic, 276; subclavian, 268, 272; traumatic, 214, 227, 249, 264, 400
Aneurysmal dilatation, 255, 269; varix, 228, 270
Angeioma, 126, 231; cavernosum, 127
Angle of neck of femur, 456
Angular curvature of spine, 801
  splints for fracture of humerus, 437; staff, 1224
Ankle, amputation of, 1378; disease of, 685; dislocation of, 602; compound, 605; excision of, 705; Mickulicz's operation on, 686; shape of, in synovitis, 614
Annular structure, 1273
Antal, cystectomy, 1237
Anterior polar cataract, 822
  tibial artery, ligature of, 300; in fractures, 400, 488
  tibial tendon, division of, 358
Anteroposterior curvature of spine, 801
Anthrax, 67; on face, 856
Antimony in inflammation, 16
Antiseptic baths in arthritis, 629; in burns, 179; in fractures, 416; gangrene, 48; in wounds of joints, 549, 560
Antiseptics, 160
Antrum, dropsy of, 882; polypi, 881; suppuration in, 880; tumours of, 885
Anus, artificial, 1091; dilatation of, in piles, 1110; epithelioma of, 1134; fissure of, 1124; fistula, 1126; imperforate, 1101; inflammation of, 1122; malformations of, 1101; prolapse of, 1114; pruritus, 1118
Aorta, aneurysm of, 261, 265; wounds of, 988
Aphasia in brain-injury, 722
Aphonia, functional, 934
Aphthous stomatitis, 875
Apparent lengthening in hip-disease, 663
Appendages, removal of uterine, 1323, 1342
Appendix, inflammation of, 1074
Apple-jelly deposit of lupus, 192
Approximation plates, 1090
Arachnoid cysts, 744, 757
Arch of foot, pegging, 368
  hæmorrhage from palmar, 220
Arcus senilis, 829
Areola. *See* Nipple
Argyll-Robertson pupil, 836
Arm, amputation of, 1374; innervation of muscles of, 778
Arrest of growth after fracture, 396, 433, 470, 488; of hæmorrhage, 211, 216
Arsenic in lichen, 189; lymphadenoma, 311; onychia, 208; pemphigus, 190; psoriasis, 188
Arterial angeioma, 232; hæmorrhage, 210; after fractures, 399; hæmatoma, 216; thrombosis, 237; varix, 232
Arteries, compression of, 257; division of coats of, 281; rules for ligature, 281; rupture of, 214; as a cause of aneurysm, 250; wounds of, 216
Arteriovenous aneurysm, 228, 270; of orbit, 845
Arteritis, 234; in syphilis, 86
Artery and vein, ligature of, 229
Arthrectomy, 656, 685
Arthritis, 619; acute, of infants, 511, 625; acute suppurative, 502, 548; consecutive, 623; deformans, 637; after dislocations, 554; exanthematic, 631; gouty, 634; neurotic, 611, 646; puerperal, 630; pyæmic, 629; rheumatic, 636; of hip, 464, 639; suppurative, 625; tubercular, 649; urethral, 631, 1267
Articular ostitis, tubercular, 679
Artificial anus, 1091; after hernia, 1032
  eyes, 846
  feeding and rickets, 529
  nose, 862
Arytenoid muscles, paralysis of, 935
Ascending paralysis, of Landry, 110
Ascites and ovarian cysts, 1330
Aspect in hernia, 1021
Aspiration in abscess, 32; in arthritis, 627; of bladder, 1196; of extravasated blood, 150; in fracture of patella, 476; in osteo-arthritis, 645; of thorax, 996

Aspirator for lithotrity, 1213
Asthenic fever, 10
Asthenopia, 818; muscular, 841
Astigmatism, 817
Astley Cooper on fracture of neck of femur, 458, 462
Astragalus, angle of, 354; dislocation of, 606; excision for talipes, 360; of head of, 368
Astringents in inflammation, 314
Asymmetry in fractures, 393; as a cause of scoliosis, 802
Atheroma, 236, 249
Atlas, dislocation of, 774, 777
Atlo-axoid disease, 791
Atony of bladder, 1189, 1241; of rectum, 1114
Atrophic catarrh of nose, 864
scirrhus, 1363
Atrophy in anchylosis, 693; of bone, 490; of cartilage, 610; of choroid, 840; as a cause of fracture, 377; after fracture, 403; of muscles in arthritis, 615, 640, 665; after nerve-section, 316, 336; after strains, 331; of neck of femur, 458; of optic disc, 836; of testis, 1304; and varicocele, 1314
Atropin, in iritis, 831
Attitude in hip-disease, 663; in spinal disease, 795
Auditory nerve, injury to, 730
vertigo, 924
Auricle, blood-tumours of, 917; malformations, 917
Auriscope, 916
Auscultation of œsophagus, 979
Avery, method of suture, 872
Axillary aneurysm, 273
artery, ligature of, 289; rupture of, 576
pad in fractured clavicle, 427

B

Bacillus anthracis, 67; of glanders, 70; of leprosy, 102; of lupus, 190; of tubercle, 73; of tetanus, 106
Back, injuries and diseases of. *See* Spine
Ball, on colotomy, 1084; on radical cure of hernia, 1040
Ballance, 753
Bandages, dextrin, 565; in fractures, 407; Pick's, 428; Sayre's, 427; in sprains, 551; triangular, 425; Velpeau's, 566
Bands, as a cause of strangulation, 1051
Bardenheuer, excision of rectum, 1138
Barker, 657, 702; on excision of tongue, 905
Bartholin's gland, 114, 1348
Barwell's shoe, 364; sling, 809
Base of skull, fracture of, 715
Baths in compound fractures, 416; in gangrene, 48; in wounds of joints, 549, 560, 628; in taxis, 1024
Beading of ribs, 528
Bed, fracture, 404
Bed-sores, 46; after fractures, 398; in injuries of spine, 781
Belladonna in aneurysm, 257; in incontinence, 1192
Bellocq's sound, 863
Berlin wool truss, 1016
Biceps tendon, absorption of, 641; dislocation, 334; rupture, 332
Bichloride of methylene, 1385
of mercury, 160
Bigelow, 1210; on fracture of femur, 460
Bilharzia, 1181
Biliary calculi, 1096
Bird's-nest bodies, 137
Birth palsy, 744
Bladder, atony of, 1189; with enlarged prostate, 1239; calculus, 1203; drainage of, 1202, 1228, 1237; in enlarged prostate, 1246; excision of, 1237; extroversion of, 1183; fissure at neck of, 1297; after fracture of spine, 780, 784; inflammation of, 1198; injuries of, 1186; irritability of, 1190; sacculated, 1199, 1208, 1275; tapping, 1196; tumours of, 1230; treatment of after cystotomy, 1236; washing out, 1202; with enlarged prostate, 1246
Blandin's gland, 114, 885
Bland Sutton, 118
Bleeding, arrest of, 213, 216; in inflammation, 14; from varicose veins, 241
Blepharitis, 185, 825, 841
Blood-clot, cystic transformation of, 149; organisation of, 5, 149; suppuration of, 149
Blood-cysts, 115; of neck, 951
in urine, 1177
Boils, 195
Bone-setting, 619, 694
Bones, absorption, 492; abscess, 496; anchylosis, 691; atrophy, 490; curving in rickets, 527; diseases of, 490; failure of growth in rickets, 527; in syphilis, 519; hypertrophy, 491; inflammation of, 491; tumours of, 124, 537
Boracic acid, 161; baths in burns, 179; fomentations, 180
Boroglyceride in peritonitis, 1078
Bose on tracheotomy, 954
Bottini's prostatotomy, 1248
Bougies, dangers of, 1278; œsophageal, 979; size of, 1277; varieties of, 1281
Boutonnière, la, 1246
Bowlby, 235, 260, 315, 776
Brachial artery, ligature of, 290
plexus, distribution of, 778; rupture, 318, 577
Brain, abscess of, 748; concussion of, 718; contusion, 719; compression, 724; cysts in, 758; glioma of, 758; gumma, 744, 758; hæmorrhage into, 720; hernia of, 756; incisions in, 761; inflammation of, 741; chronic, 744; lacera-

tions of, 719; sarcoma of, 758; softening of, 742; suppuration in, 746; syphilitic disease of, 92; tubercle of, 745, 758; tumours of, 745, 757; wounds of, 727
Branchial cysts, 117, 952; fistula, 937
Brasdor's method of ligature, 259, 262
Breast, abnormalities of, 1352; adenoma, 1360; adenosarcoma of, 131; cystic disease of, 115, 1359; enchondroma of, 124; fibro-adenoma, 136; hypertrophy of, 1352: inflammation of, 1354; lobular induration of, 1357; removal of 1369
Breast, pigeon-, 528
Bridle stricture, 1273
Broad ligament cysts, 115, 1329
Brodie's disease of the breast, 115, 1361
Bromide eruptions, 195
Bronchi, foreign bodies in, 944
Bronchocele. *See* Thyroid
Broncho-pneumonia after operations on the tongue, 906; after wounds of the neck, 940
Bruit in aneurysm, 252
Brunton's speculum, 916
Bryant, 222; on ostitis deformans, 534; splint, 470, 669; triangle, 457
Bubo, 304; syphilitic, 80, 83; suppurating, 83, 304
Bubonocele, 1301
Buccal cysts, 884
Buckston-Browne's tampon, 1222
Bulb, suppuration in, 1294
Bulbous sounds, 1279
Bullæ, after extravasation, 150; after nerve-section, 317; in pemphigus, 189
Buller's shield, 823
Bunion, 370
Buphthalmos, 833
Buried sutures, 164
Burns, classification of, 176; of the eye, 818; scars of, 172
Burow's operation, 825
Bursæ, affections of, 346, 370
Button sutures, 164
Buzzard on neuritis, 325

C

Cæcectomy, 1090
Cæcum, inflammation of, 1074
Calcification of enchondroma, 124; in rickets, 526
Calculous pyelitis, 1156
Calculus, biliary, 1096; in the female, 1230; physical characters of, 1205; prostatic, 1254; renal, 1152; salivary, 912; solution of, 1157; sounding for, 1209; tests for, 1207; tonsillar, 911; vesical, 1203; in ureter, 1146, 1157
Callus, 381; in fracture of patella, 475; of skull, 716; tumours, 386
Canal, suture of inguinal, 1041
Cancellous exostosis, 125, 537
Cancroid, 137
Cancrum oris, 856
Capillary hæmorrhage, 209
hæmorrhoids, 1106
Carbolic acid, 161; in acne, 195; in bleeding, 209; in boils, 196; in hydrocele, 1323; in piles, 1110
Carbuncle, 195; of face, 855
Carcinoma, 136; of bladder, 1232; bone, 546; breast, 1362; en cuirasse, 1363; as a cause of fracture, 379; of jaws, 887; kidney, 1151; larynx, 931, 962; œsophagus, 977; penis, 1299; prostate, 1250; rectum, 1134; uterus, 1345; villous, 115
Carcinomatous cysts, 953
Carden's amputation, 1372, 1377
Caries, 495; fungosa or sicca, 493, 523; of spine, 789; syphilitic, 516; tubercular, 525
Carotid, aneurysm of, 268; compression of, 284; ligature of, 282; external, 284; internal, 285; wounds of internal, 875; wounds of, 939
Carotid and subclavian, ligature of, 261
Carpus, dislocation of, 584
Carr's splint, 448
Carron oil, 180
Cartilage, absorption of, 610, 637; atrophy of, 610; in callus, 382; fibrillation of, 637; fracture of, 384; inflammation of, 610; necrosis of, 610; in rickets, 526; sloughing of, 626; tubercular infiltration of, 650
Cartilages, loose in joints, 639, 688
of knee-joints, dislocation of, 599
Caruncle, urethral, 1297, 1348
Caseation in actinomycosis, 72; farcy, 50; hip-disease, 669, 675; leprosy, 103; lymphatic glands, 306; syphilis, 88; tubercle, 76, 652, 679
Caseous abscesses, 28, 31
Castration, 1314
Cataract, 831; anterior polar, 822, 831; concussion, 831; lamellar, 832; operations for, 848; posterior polar, 832; pyramidal, 822; senile, 832; traumatic, 819
Catarrhal inflammation of conjunctiva, 821; ear, 921; larynx, 925; nose, 864; mouth, 875; rectum, 1119; tonsil, 907
Catarrhal suppuration in joints, 613
Catgut ligatures, 223
Catheterisation of ureter, 1168
Catheters, accidents from, 1262; in enlarged prostate, 1244; method of tying in, 1263; size of, 1277
Cauda equina, injury to, 775, 782
Causalgia after nerve-section, 317; in neuritis, 324
Caustics in lupus, 193; phagedæna, 101
Cautery in hæmorrhage, 219, 252; in laryngeal growths, 933; joint-disease, 623; in nævi, 201; for piles, 1111; prolapse of rectum, 1116; tonsillitis, 909; tubercular glands, 308
Cavernous angeioma, 127, 231; lymphangeioma, 311; tumours, 126

Cell-nests, 137
Cellulitis, diffuse, 51; and erysipelas, 52; after lithotomy, 52; of orbit, 53; of neck, 53, 948: after poisoned wounds, 52; of scalp, 53, 709, 736
Central necrosis, 509
  sarcoma of bone, 542
Cephalhæmatoma, 148, 498, 708
Cephalhydrocele, 712
Cerebellar abscess, 750, 753; trephining for, 756
Cerebral abscess, 748; after otitis, 921; trephining for, 755; localisation of, 753
Cerebral hæmorrhage, 729
  hernia, 756
  hyperæmia, 745; after injury, 721
  irritability, 745
  localisation, 763
Cerebritis, 741
Cerebrospinal fluid, escape of, 716
Cerumen, accumulation of, 917
Cervical fascia, section of, 950
  nerves, distribution of, 778
  vertebræ, fracture of, 778
Cervix uteri, amputation of, 1346; laceration, 1349
Chalazion, 843
Chancre, 81; duration of, 83; of eyelid, 843; excision of, 97; relapsing, 83; treatment of, 101
Chancroid, 79
Charcot's disease, 646
Chassaignac's drainage-tubes, 168
Cheiro-pompholyx, 190
Cheloid, 174
Chemical irritants causing inflammation, 53, 500, 611; causing fever, 66
Chemosis, 823
Chest, abscess of, 993; aspiration, 996; drainage, 996; injuries of, 982; tubercle, 995; wounds, 985
Chicken-bone drains, 169
Chills in suppuration, 158
Chimney-sweep's cancer, 136, 1300
Chloasma, 207
Chloride of zinc, 161; for abscesses, 33
Chloroform, 1384; in delirium, 145
Cholecystectomy, 1098
Cholecystotomy, 1098
Chondrosarcoma, 125, 129
Chordee, 1266
Choroid, diseases of, 839; in myopia, 817; in syphilis, 828; rupture of, 821
Chopart's amputation, 1379
Chromic acid applied to the tongue, 897, 898
Chronic abscess, 29; of bone, 496, 499; of breast, 1358
  ostitis, 499
  synovitis, 616
Chrysarobin in favus, 204
Chrysophanic acid in psoriasis, 188; in tinea, 207
Chylous hydrocele, 313
Chyluria, 313, 1179
Cicatrices, 153, 171; in syphilis, 85
Circular amputation, 1371; of the arm, 1374
Circulation in fracture of spine, 779; effect of irritants on, 3
Circumcision, 1298
Circumflex nerve, rupture of, 577
Cirsoid aneurysm, 232
Civiale's urethrotome, 1286
Clamp, for enterectomy, 1085; for piles, 1111
Clavicle, dislocation of, 563; fracture, 423; sarcoma, 545
Cleft palate, 871
Cloacæ, 504
Closure of jaws, 882
Clot: active and passive, 251; cysts from, 149; in hæmorrhage, 211; laminated, 251, 256; organisation of, 5, 149; suppuration of, 149
Clove-hitch, 574
Clover's crutch, 1217; inhaler, 1383
Club-foot, 353
Club-hand, 352
Coagulation necrosis, 24
  and thrombosis, 242
Coates' truss, 1016
Cocaine, 1383; in enterotomy, 1060; in stricture, 1282
Coccidia, 1354
Coccygodynia, 454
Coccyx, fracture of, 454
Cock's operation, 1290
Cod-liver oil in rickets, 531
Coin-catcher, 975
Colchicum in gout, 635
Cold abscesses, 29
  affusion in delirium, 145
  in arthritis, 616, 622; in bleeding, 219; as a cause of shock, 141; inflammation, 13, 416; in taxis, 1024; as a cause of neuritis, 324
Colectomy, 1089
Coleman's gag, 872
Cole's truss, 1014
Colic, renal, 1153; in intestinal obstruction, 1068
Collapse in burns, 177; in strangulation, 1055
Collateral circulation, 40, 225, 246
Colles' fracture, 445; law, 94
Colloid carcinoma, 139
Colotomy, 1081; in stricture of rectum, 1134
Coma distinguished from concussion, 726
Comedones, 194
Common iliac, ligature of, 295
Compact exostosis, 125
Compensatory curve of spine, 802
Compound dislocations, 559
  fractures, amputation in, 412, 417, 472; into joints, 417; treatment of, 411
  palmar ganglion, 342
Compression in abdominal aneurysm, 275; in aneurysm, 257, 263; of aorta, 294;

in arthritis, 616, 622; of brachial artery, 292; of brain, 724, 732; of carotid 284; in caries, 791; in extravasations, 151; for hæmorrhage, 220; as a cause of intestinal obstruction, 1065; of spinal cord, 786; in sprains, 551; of subclavian, 288
Concussion and alcoholic coma, 726; of brain, 718; of eye, 820; cataract, 831; and opium coma, 726; and uræmia, 726; treatment of, 731
Condylar fracture of humerus, 442
Condylomata, 84, 101
Cone of light, 916
Confinement as a cause of anchylosis, 692
Congenital cyst, 116; cystic tumour, 311
  dislocation, 350
  hydrocele, 1317
  hygroma, 119, 127, 311, 951
  hypertrophy, 312
  inguinal hernia, 1033
  lipoma, 122, 769
  sacral tumour, 117, 769
  syphilis. *See* Hereditary
  talipes, 353
  umbilical hernia, 1046
Congestion in burns, 178; after fractures, 398; due to thrombosis, 241
Congestive stricture, 1273
Conical cornea, 829
  stump, 1382
Conjunctivitis, 821; gonorrhœal, 823; granular, 823
Consecutive arthritis, 623
  displacement in dislocation, 552
  meningitis, 742
Constipation after fractures, 398; in hernia, 1023, 1056; in obstruction, 1068
Contagiousness, duration of, in syphilis, 86
Continued fever, 11
Continuous baths in compound fractures, 416
  extension in fractures, 406
  suture, 168
Contraction of muscles as a cause of fracture, 380, 474; in arthritis, 615; after nerve-injury, 322
Contraction of palmar fascia, 344
  of scars, 172
Contracture, 337; after fractures, 403
Contrecoup, 715, 722; fracture by, 380
Contused wounds, 151, 171
Contusions, 148; of abdomen, 1002; of brain, 719; of chest, 982; as a cause of ostitis, 498; of eye, 820; of joints, 550; scalp, 708; spinal cord, 785
Convergent strabismus, 816
Convulsions and rickets, 530; after injuries to the brain, 722; in compression, 724
Copaiba rash, 1269
Coracoid, fracture of, 429
Coredialysis, 821
Cornea, conical, 829; diseases of, 825; epithelioma of, 829; foreign bodies in, 825; leucoma of, 826; nebula on, 826; ulcers of, 826
Coronoid process, separation of, 450
Corpus spongiosum, abscess of, 1295
Corrosive sublimate, 160
Cortical lesions, 722; in cerebral tumours, 758
Coryza, 864; iodide, 100
Costal cartilages, fracture of, 983
Coster's paste, 205
Counter-irritants, 14, 19; in delayed union of fractures, 390; in neuritis, 325
Counter-openings in compound fractures, 415
Coup de fouet, 332
Cowper's glands, 114; suppuration in, 1266, 1294
Cramp, writer's, 335
Cranial nerves, injuries of, 717, 729
Craniotabes, 96, 527, 738
Cranium, nodes on, 515; in rickets, 527. *See* Skull
Crepitus as a sign of fracture, 394
Cretification in tubercle, 77
Cretinism, 965
Cricothyroid muscles, paralysis of, 935
Croup and rickets, 530, 935; spasmodic. 944
Croupous exudation, 8
Crushing for piles, 1111
Crutch paralysis, 318
Cubebs, 1269
Cupping, 14
Curvature of spine, 800; in rickets, 528
Cut throat, 937
Cyanide of zinc and mercury, 161
Cyclitis, 831
Cylindrical-celled carcinoma, 138
Cylindroma, 120, 131
Cyrtometer, Wilson's, 763
Cystectomy, 1237
Cystic adenoma of breast, 1360; of ovary, 1326
  adenoma of testis, 1312
  degeneration of breast, 115, 1359; of enchondroma, 124; sarcoma, 542
  ganglion, 342
  goître, 966
  sarcoma of breast, 1361
Cystin in urine, 1175
Cystitis, 1198; in enlarged prostate, 1240; in fracture of spine, 780
Cystoscope, 1233
Cystotomy, 1226, 1235
Cysts, 113; of antrum, 882, 887; arachnoid, 744, 757; from blood, 149; in bone, 546; brain, 758; branchial, 952; of breast, 1359; carcinomatous, 953; dentigerous, 888; eyelids, 844; face, 858; hyolingual, 952; inflammatory, 115; jaws, 888; kidney, 1151; labium, 1348; broad ligament, 1329; larynx, 933; of mouth, 884; meibomian, 843; of pancreas, 1099; periosteal, 882, 888; of pharynx, 953; popliteal, 349; of scalp, 737; from the semimembranosus bursa,

644 ; thyroid, 953 ; of tongue, 900 ; of vagina, 1348
Czerny's suture, 1087

D

Dactylitis, 524
Darier, 185, 1353
Davies Colley, 68
Davy's rectal lever, 218, 295
Deafness in hereditary syphilis, 97
Decalcified drainage-tubes, 169
Decomposition in wounds, 157
Defæcation after injuries to spine, 781
Definitive callus, 381
Deformity in caries of spine, 791 ; in disease of knee, 681 ; in fracture of spine, 775 ; in hip-disease, 665 ; in infantile paralysis, 361 ; in leprosy, 104 ; as a sign of fracture, 393 ; in rickets, 531
Degeneration of arteries, 237 ; from arterial obstruction, 246 ; gelatiniform, of bone, 519 ; of nerves after division, 315 ; of thrombi, 244
Delayed union, 388
Delirium after fractures, 398 ; tremens, 144
Demarcation in gangrene, 41 ; in necrosis, 509
Dentigerous cysts, 888
Deposits in urine, 1179
Derangement of knee, internal, 599
Dermoid cysts, 117 ; of brain, 758 ; breast, 1359 ; eyelids, 844 ; face, 859 ; mouth, 885 ; ovary, 1327 ; scalp, 737 ; spine, 769 ; tongue, 900
Desault's splint, 465
Descent of testes, 1302
Detachment of iris, 821 ; of retina, 838 ; in myopia, 817
Dextrin bandages, 565
Diabetes, 1179
Diaphragm, rupture of, 988 ; hernia through, 1048
Diathesis, hæmorrhagic, 233
Didot, 353
Diet in inflammation, 15 ; in rickets, 53
Diffuse lipoma, 122
  inflammation of cellular tissue, 51 ; of neck, 948
  suppuration, 24, 29 ; of meninges, 748 ; of muscles, 337
Digital compression, 258 ; for hæmorrhage, 219
Digitalis in aneurysm, 257
Dilatation, aneurysmal, 255 ; of anus, 1110 ; of stricture, 1280 ; of œsophagus, 979 ; of rectum, 1133 ; of female urethra, 1236
Dilator, Golding Bird's, 945
Dioptric system, 815
Diphtheria, tracheotomy in, 958
Diphtheritic exudation, 8
  inflammation of conjunctiva, 823
  of cellular tissue of neck, 948
  paralysis of eye, 841
Direct inguinal hernia, 1035
Disc, inflammation of optic, 836
Dislocations, 552 ; amputation for, 560 ; of ankle, 602 ; astragalus, 606 ; clavicle, 563 ; compound, 559 ; congenital, 350 ; by destruction, 630, 661 ; by distension, 630, 666 ; diagnosis of, 556 ; of elbow, 578 ; excision for, 560 ; of finger, 587 ; and fractures, 561, 402, 435 ; of foot, 603 ; of hip, 587 ; of humerus, 566 ; of knee, 598 ; of lens, 821 ; of lower jaw, 561 ; of muscles, 334 ; by muscular action, 561 ; of os magnum, 584 ; of patella, 597 ; of pisiform bone, 585 ; of radius, 582 ; of radius and ulna, 578 ; recurrent, 569 ; reduction of, 557 ; by manipulation, 557, 571 ; by extension, 558, 574 ; by hyperabduction, 575 ; of scapula, 565 ; of semilunar cartilages, 599 ; of spine, 774 ; subastragalar, 607 ; of tendons, 334 ; of thumb, 585 ; of ulna, 582 ; unreduced, 554, 576 ; of wrist, 584
Disorders, of muscles, functional, 334
Displacement, consecutive, in dislocation, 553 ; as a sign of fracture, 393 ; of tibia in disease of knee, 681
Dissecting aneurysm, 249
Distal compression for aneurysm, 263
  ligature for aneurysm, 260
Distension of abdomen in strangulation, 1059
  of bladder, method of, 1226
  in intestinal obstruction, 1068
  of rectum, method of, 1227
Distribution of leprosy, 102
Divergent strabismus, 817
Division of coats of arteries by ligature, 281
  of stricture of rectum, 1133
  of stricture of urethra, 1285
Doran, 116
Dorsal abscess in disease of spine, 794
  dislocation of hip, 591
  vertebræ, fracture of, 781
Dorsalis pedis, ligature of, 301
Double inclined plane, 468
  ligature for arteries, 224, 281
Douching in inflammation, 19
Drainage of abscesses, 799 ; of antrum, 882 ; in arthritis, 628 ; of bladder, 1202, 1228, 1246 ; in compound fractures, 415 ; of chest, 996 ; in goitre, 970 ; of hydrocele, 1320 ; of knee-joint, 549 ; of the medulla of bones, 507 ; tubes, 30, 168 ; in wounds, 162, 167
Dressings of compound fractures, 414 ; of wounds, 163
Drilling in fracture of patella, 477
Dropsy of antrum, 882 ; of gall-bladder, 1097
Dry gangrene, 39, 43, 246
Dumb madness, 110
Duodenal ulcer in burns, 178
Duodenojejunal fossa, 1050
Dupuytren's classification of burns, 176

Dupuytren's contraction, 344; enterotome, 1092; fracture, 486; splint, 487
Dura mater, fungus of, 740; inflammation of, 741; sarcoma of, 740; tumours of, 757; wounds of, 727
Duverney, 583
Dysentery as a cause of stricture, 1064; and ulcer of rectum, 1120
Dysphagia from compression, 978; paralysis, 976
Dyspnœa in anæsthesia, 1385; after tracheotomy, 958

E

Ear, eczema of, 917; examination of, 914; exostoses of, 918; foreign bodies in, 919; fungi, 917; furuncles, 918; granulations, 920; hæmorrhage from, 717; inflammation of, 748, 919; polypi, 920; suppuration in, 920
Eburnated exostoses, 125
Eburnation, 638
Ecchymoses, 149; in fractures, 395
Ecraseur for removal of tongue, 904
Ecthyma, 184
Ectopic gestation, 1324
Ectopia vesicæ, 1183
Eczema, 184; of ear, 917; face, 854; marginatum, 185, 206; of nipple, 185, 1353; rimosum, 184; of scalp, 735
Eczematous urethritis, 1267
Elastic ligature for fistula, 1130
  tourniquet, Lloyd's, 1375
Elbow, anchylosis of, 693; dislocation of, 552, 578; excision of, 697; fracture near, 438, 443; shape of, 614; syphilis of, 519; tubercle of, 687
Electrolysis in ectopic gestation, 1325; in goître, 970; for nævi, 201, 231; for nasal polypi, 869; in stricture of the rectum, 1132; of the urethra, 1291; in uterine fibroids, 1342; in trichiasis, 82
Elephantiasis, 312, 1300
Elevation in arthritis, 622; in fractures of the skull, 714; in hæmorrhage, 221
Ellis's splint, 427
Embolic abscesses, 58; arteritis, 234; gangrene, 44
Embolism, 245; in aneurysm, 253; as a cause of aneurysm, 250; fatty, 397, 506; in fractures, 401; in pyæmia, 57; in suppuration, 28; in tubercle, 75, 524, 609, 650
Emotion as a cause of shock, 141
Emphysema, 991; interstitial, 982, 992
Emprosthotonos, 105
Empyema, 994; as a cause of scoliosis, 803; of gall-bladder, 1097
Encephalocele, 706
Enchondroma, 123; of bone, 529; of jaws, 886; of testis, 1312
Enclavement, 117
Encysted calculus, 1155, 1158
  hernia, 1035; hydrocele, 1319

Endarteritis, 234
Endocarditis, 235, 246
Endothelioma, 132
Enemata in intussusception, 1062; in obstruction, 1072
Enlarged prostate, 1238; catheterism for, 1244; retention in, 1195
  tonsils, 908
Enterectomy, 1085
Enterocele, 1012
Enteroepiplocele, 1012
Enterorrhaphy, 1087
Enterostomy, 1079
Enterotome, Dupuytren's, 1092
Enterotomy in strangulation, 1059
Entropion, 824
Enucleation of goître, 970; of uterine fibroids, 1342
Epicondyle of humerus, separation of, 441
Epidemic goître, 968
  tetanus, 106
Epidermic globes, 137; grafting, 154
Epidermis, repair of, 153
Epididymitis, syphilitic, 86, 1307; tubercular, 1308; urethral, 1304
Epilepsy after nerve-injury, 323; traumatic, 735; neuralgia, 326; nerve-stretching in, 329; ligature of vertebral arteries for, 288
Epiphora, 842
Epiphyses, acute inflammation of, 502, 511; tubercular inflammation, 651; separation of, 396; of humerus, 432, 442, 580; of femur, 470; of radius, 444; of tibia, 488; in ostitis, 506; premature union of in rickets, 527; in syphilis, 519; union after separation, 433, 470, 488, 495
Epispadias, 1298
Epistaxis, 862
Epithelioma, 136; of bladder, 1232; face, 860; gums, 885, 888; intestine, 1065; after lupus, 190; of œsophagus, 977; penis, 1299; rectum, 1134; scars, 175; scrotum, 1300; tongue, 900
Epulis, 129, 541, 886
Erasion, 695; in caries, 525
Ergot in uterine fibroids, 1341
Erichsen's splint, 432
Eruptions after nerve-section, 317; iodide, 100; serpiginous, 90; syphilitic, 84
Erysipelas, 62, 313; and cellulitis, 52, 62; of face, 857; of scalp, 735
Erythema in leprosy, 103; nodosum, 184
Erythematous tonsillitis, 907; lupus, 193
Escape of cerebrospinal fluid, 716
Eserine in glaucoma, 834
Esmarch's bandage, 217, 260; operation 883
Estlander's operation, 999
Ether, 1384; spray, 1383
Eucalyptus oil, 161
Eustachian catheter, 915

EVA

Evacuating tubes, 1213
Evolution cysts, 115
Examination of bladder, 1209; breast, 1358, 1364; calculi, 1207; eye, 814; joints, 612; prostate, 1243; rectum, 1071; spine, 807; scrotum, 1300; testis, 1313; urethra, 1260, 1278
Exanthematic arthritis, 631; necrosis, 513
Excision of the ankle, 705; compared with arthrectomy, 656; of the astragalus, 360; of wall of bladder, 1237; of breast, 1369; of cirsoid aneurysm, 233; of condyle of jaw, 883; in compound dislocation, 560; of the elbow, 697; of eyeball, 846; of the hip, 676, 701; hydrocele, 1320; jaws, 889; knee, 479, 703; lymph-glands, 307; larynx, 932, 962; Meckel's ganglion, 329; of nævi, 201, 232; piles, 1112; prolapse of rectum, 1117; rectum, 1136; rib, 999; shoulder, 696; stricture, 1291; subperiosteal, 696; thumb, 701; tongue, 902; tonsils, 910; varicocele, 1316; varicose veins, 241; wrist-joint, 699
Excitement in shock, 142
Exclusion of aneurysm, 264
Exercises in lateral curvature, 808
Exfoliation, 508; after scalp wounds, 710
Exophthalmic goître, 966, 972
Exostoses, 125, 537; of cranium, 740; of auditory meatus, 918; of jaws, 886
Expansile pulsation, 252
Expansion of bone, 493, 524
Exploring needle, 30
Extension in arthritis, 622; as a cause of anchylosis, 692; for cicatrices, 172, 181; in dislocations, 557, 574; in dislocation of the spine, 783; in fractures, 406; in hip-disease, 670
Extensor tendons of wrist, dislocation of, 334
External hæmorrhoids, 1105
  iliac, ligature of, 296
  urethrotomy, 1288
Extirpation of uterus, 1347
Extra-articular anchylosis, 691
Extraction of cataract, 848
Extra-uterine fœtation, 1324
Extravasation of blood, changes in, 5; 149; treatment of, 150
  of urine, 1292; from kidney, 1143
Extroversion of bladder, 1183
Exudation in chronic inflammation, 17; cysts, 113; varieties of, 8
Eye, diseases of, 821; injuries, 818; examination of, 814
Eyeball, excision of, 846
Eyelids, diseases of, 841

F

Face, acne of, 194, 855; anthrax, 67, 856; carbuncle on, 855; dermoid cysts of, 117, 858; eczema of, 854; epithelioma, 860; erysipelas, 857; fracture of bones of, 418; herpes, 854; inflammation of, 854; lupus, 190, 857; leprosy, 103, 858; malformations, 850; molluscum, 202, 859; rhinoscleroma, 858; syphilis, 96, 857; tinea, 204, 854; rodent ulcer, 137, 859
Facial artery, ligature of, 286
  nerve, injury to, 730; neuralgia of, 326
Fæcal accumulation, treatment of, 1073
  fistula, 1032, 1091
Fæces as a cause of obstruction, 1069
Failure of growth in rickets, 527; in syphilis, 519
  of union, 387; of humerus, 438; of patella, 478
Fallopian tubes, inflammation of, 1322
False joints, 387; of humerus, 438
  passages, 1262, 1282
  spina bifida, 765
Farabœuf, 586
Faradic excitability after nerve-section, 316
Faradisation in dysphagia, 977
Farcy, 70
Fascia, section of cervical, 949; of plantar, 357; contraction of palmar, 344; lata, in diagnosis of fractured femur, 464
Fat-embolism after fractures, 397; in ostitis, 506; in urine, 1179
Favus, 204
Feeding after herniotomy, 1031; laparotomy, 1061; tracheotomy, 957
Fehleisen, 62
Femoral aneurysm, 277; ligature of artery, 297; compression, 297; hernia, 1043
Femur, absorption of neck, 464, 639; amputation of, 1376; dislocation of, 587; fracture, 455; necrosis of head of, 660; ostitis of neck, 651, 659; in rickets, 529
Fergusson's staff, 1218
Ferments, fever-causing, 10, 20, 66, 147
Fever, causes of, 9; in fracture, 397; neurotic, 147; septic, 20, 157; syphilitic, 83; traumatic, 20, 146; urethral 1262; varieties of, 10
Fibrinous synovitis, 609
Fibroblasts, 6
Fibro-cellular tumour, 120
Fibro-enchondroma, 123
Fibroid polypi of nose, 868; tumours of uterus, 1338; recurrent, 132
Fibroma, 119; of bone, 541; of breast, 1361; dura mater, 757; jaws, 886; larynx, 932; ovary, 1326; sarcoma, 129; of testis, 1312
Fibrous anchylosis, 691
  goître, 966
  union of fractures, 387
Fibula, fracture of, 485
Field of vision, limitation of, 837
Figure-of-eight bandage, 428; suture, 165

Filaria sanguinis hominis, 313
Fingers, amputation of, 1374; dislocation of, 587; enchondroma of, 124; supernumerary, 350; webbed, 353
First intention, union by, 151
Fissure of anus, 1124; at neck of bladder, 1297; of tongue, 898; syphilitic, 84
Fissured fracture, 711
Fistula, 36; in ano, 1126; bi-mucosa, 1033; branchial, 937; fæcal, 1091; rectovaginal, 1349; renal, 1167; urethral, 1295; urinary, 1295; vesico-vaginal, 1349
Fistula and phthisis, 1130
Fitzgerald, 361
Fixation in talipes, 356
Fixed splints for fractures, 410
virus, 111
Flail joints, 697
Flap amputations, 1371
Flat foot, 366; after fracture, 488; gonorrhœal, 633
Flexion in aneurysm, 260, 262, 279; in hip-disease, 665
Flexor tendons, sprain of, 449
Floating kidney, 1141
Fluctuation, 25
Fœtus, attached, 770; parasitic, 118
Folding a hernial sac, 1040
Follicular prostatitis, 1251; stomatitis, 875; tonsillitis, 907
Food, as a cause of rickets, 529
Foot, amputation of, 1379; dislocation of, 603; fracture of, 490
Forci-pressure, 221
Forearm, amputation of, 1374; dislocation, 578
Forehead, dermoid cysts of, 117
Foreign bodies in air-passages, 942; in aneurysm, 263; in ear, 919; in the eye, 819, 825; in joints, 639, 689; in lung, 993; nose, 853; as a cause of obstruction, 1066; in palate, 875; in pharynx, 974; in urethra, 1259; in wounds, 157
Fossa duodenojejunalis, 1050; intersigmoid, 1050; subcæcal, 1050
Four-tailed bandage (Pick's), 418
Fourth nerve, injury to, 730
Fractures, 375; of acetabulum, 453; amputation in, 411, 417, 472; of base of skull, 714; bed for, 404; of bones of face, 418, 853; of carpus, 451; clavicle, 423; by contre-coup, 715; of coccyx, 454; depressed, of skull, 711; and dislocation, 435, 561; in reduction of dislocation, 577; Dupuytren's, 486; of elbow, 438; femur, 455; fibula, 485; foot, 490; humerus, 430; hyoid, 941; into knee-joint, 473, 479; larynx, 941; malar bone, 419; maxillæ, 418; metacarpus, 451; by muscular action, 380, 474; of nasal bones, 418; of patella, 473; Pott's, 486, 602; of pelvis, 453; reduction of, 405; of radius, 443; of radius and ulna, 451; of ribs, 983; in sarcoma, 544; of scapula, 429; of sacrum, 454; into shoulder-joint, 435; of spine, 773; of sternum, 985; of skull, 710; of tibia, 485; of tibia and fibula, 480; of ulna, 449; of vault of skull, 710
Fragilitas ossium, 378
Friction as a cause of inflammation, 16
Fringes, synovial, 639, 689, 509
Frog's skin, grafting of, 156
Frost-bite, 44, 50
Fumigation in syphilis, 99
Functional aphonia, 934; disorders of muscle, 334
Fungi in ear, 917
Fungus of dura mater, 741
Furneaux Jordan's amputation, 1375; plaster jacket, 798
Furuncles in ear, 918
Fusiform aneurysm, 249

G

Gags, 872
Galactocele, 1360
Gall-bladder, diseases of, 1096
Gall-stones as a cause of obstruction, 1066; of strangulation, 1055; treatment of impacted, 1060
Galvanic excitability after nerve-section, 316
Galvanism in nerve-injury, 320; in delayed union, 390
Galvanopuncture in aneurysm, 263
Gamgee's antiseptics, 414; dressings, 161; splints, 409
Ganglion, 114, 341
Gangrene, amputation in, 49; in aneurysm, 260, 279; after ligature of artery, 225, 246; causes, 39; embolic, 44, 246; in fractures, 403, 416; due to nerve-irritation, 40; in hernia, 1030; in intussusception, 1054, 1063; hospital, 51; moist, 45; senile, 43; in spinal injury, 777; symmetrical, 44; thrombotic, 43
Gangrenous stomatitis, 856
Gärtner's duct, 116
Gastroduodenostomy, 1008
Gastrostomy, 1007; for stricture, 980
Gastrotomy, 976, 1009
Gelatiniform degeneration of bone, 519
Generalisation of sarcoma, 132
Genu recurvatum, 352; valgum, 371
Gestation, ectopic, 1324
Giant-cells in syphilis, 88; in tubercle, 76
Glanders, 70
Glands, caseating, 306; excision of, 307; in erysipelas, 64; inflammation of, 304; in neck, 948; tubercular, 306
Glandular tumours of breast, 1359
Glaucoma, 833
Gleet, 1266, 1271
Glenoid fossa, fracture of, in dislocation, 577

Glioma, 131 ; of brain, 758 ; of choroid, 840
Globe, rupture of, 821
Glossitis, 893
Glottis, scald of, 946
Glover's suture, 166
Gluteal aneurysm, 276 ; ligature of artery, 295
Godlee, 1000
Goître. *See* Thyroid
Golding-Bird's dilator, 945
Gonococcus, 1265
Gonorrhœa, 1265 ; complications of, 1267 ; conjunctivitis in, 823 ; epididymitis, 1304 ; prostatitis, 1251 ; rheumatism, 366, 631, 1267
Gooch's splint, 436
Gordon on Colles' fracture, 447 ; splint, 448
Gorget, 1220 ; Teale's, 1290
Gout, 17 ; arteritis in, 236 ; arthritis, 634 ; iritis, 831 ; neuritis, 324 ; orchitis, 1310 ; phlebitis, 247 ; prostatitis, 1253 ; urethritis, 1267
Gowers' tumour of spinal cord, 812
Graäfian follicle cysts, 115, 1328
Grafting, bone, 393 ; in burns, 181 ; frog's skin, 156 ; mucous membrane, 156 ; nerves, 321 ; omentum, 1088 ; skin, 154 ; tendons, 333
Granular conjunctivitis, 823
Granulation tissue, 6, 152
Granulations, in ear, 920 ; healing by, 153
Granuloma, 8 ; fungoides, 534
Graves's disease, 966
Grawitz on peritonitis, 1077
Great toe, deformities of, 369
Greenstick fracture, 376
Greig Smith on enterectomy, 1085 ; on intestinal strangulation, 1059 ; on peritonitis, 1078
Gritti's amputation, 1377
Growth, arrest of after fracture, 396, 433, 470, 488 ; in rickets, 527 ; in syphilis, 519
Gum and chalk bandage, 409, 482
Gummata in bone, 515 ; brain, 758 ; bursæ, 348 ; in hereditary syphilis, 96 ; histology of, 88 ; of iris, 829 ; in muscle, 338 ; of skull, 740, 744 ; of testis, 1307 ; tongue, 898 ; treatment of, 102
Gums, hypertrophy of, 884
Guthrie's perineal section, 1289
Gutta-percha in fracture of jaw, 420
Gutter fractures, 711
Gymnastics in lateral curvature, 808

H

Hæmarthrosis, 613
Hæmatocele, 148, 1320
Hæmatoma, 148 ; arterial, 215, 277 ; of chest-wall, 985
Hæmatomyelia, 785
Hæmatosalpinx, 1322
Hæmaturia, 1177 ; after spinal injury, 772 ; in enlarged prostate, 1242 ; in villous tumour, 1232
Hæmophilia, 233
Hæmoptysis, 990
Hæmorrhage, 209 ; into abscesses, 35 ; in aneurysm, 254 ; as a cause of shock, 141 ; in cleft palate, 874 ; in chest injuries, 988 ; in cut throat, 938 ; diagnosed from shock, 143 ; from ear, 717 ; into eye, 820, 839 ; in fractures, 399, 414 ; intracranial, 727 ; from kidney, 1143 ; after lithotomy, 1222 ; in myopia, 817 ; from middle meningeal, 727, 732 ; after ovariotomy, 1338 ; into peritoneum, 1004 ; after piles, 1113 ; into spinal canal, 786 ; secondary, 210, 259 ; treatment of, 226 ; subperiosteal, in rickets, 532 ; in tracheotomy, 956 ; after wound of tonsil, 875, 911 ; after urethrotomy, 1287 ; from varicose veins, 241
Hæmorrhagic diathesis, 233 ; exudation, 8 ; infarct, 58, 246 ; sarcoma, 115
Hæmothorax, 989
Hagedorn's needles, 166
Hahn's tampon, 957
Hallux flexus, 369 ; rigidus, 369 ; valgus, 370
Hamilton, on cold abscesses, 53
Hammer-toe, 368
Hammond's wire splint, 321
Hand, club, 352 ; fractures of, 452 ; tendon sheaths of, 341 ; incisions into, 341
Hard cataract, extraction of, 848
Hare on cerebral localisation, 763
Hare-lip, 850 ; pins, 165
Harrison's truss, 1043 ; whip bougies, 1282 ; on enlarged prostate, 1241 ; draining bladder, 1247
Healing by first intention, 151 ; under scab, 153
Heart, failure of, in anæsthesia, 1385 ; wounds of, 987
Heat, in arthritis, 616 ; hæmorrhage, 219 ; taxis, 1024
Hectic, 27, 34
Helplessness in fractures, 395
Hemianæsthesia in railway injuries, 788
Hereditary syphilis, 95 ; choroiditis in, 828 ; laws of transmission, 94 ; ostitis in, 518 ; teeth in, 828
Heredity in syphilis, 87 ; in tubercle, 74
Hernia, 1010 ; anatomy of, 1011 ; causes of, 1010 ; cerebri, 756 ; congenital, 1033 ; diaphragmatic, 1048 ; direct inguinal, 1035 ; encysted, 1035 ; femoral, 1043 ; inflamed, 1009 ; inguinal, 1033 ; diagnosis of, 1301 ; internal, 1050 ; infantile, 1035 ; irreducible, 1016 ; of lung, 992 ; lumbar, 1049 ; Littre's, 1022 ; obstructed, 1018 ; obturator, 1047 ; perineal, 1048 ; pudendal, 1048 ; radical cure of, 1037, 1045 ; sciatic, 1049 ; strangulated, 1019 ; of testis, 1310 ; tunicary of bladder, 1275 ; of joints, 617, 640, 644 ; umbilical, 1046 ; ventral, 1047

Herniotomy, 1028, 1037
Herpes labialis, 26; on face, 854; gestationis, 190; after nerve-section, 317; preputial, 81
Hey, 599, 1381
Hill's, Berkeley, urethrotome, 1285
Hilton's case of gangrene, 40; on opening abscesses, 30
Hip: amputation of, 1375; anchylosis, 676; contusion, 464; disease of, 659; and hysteria, 667; and bursitis, 668; and ostitis of femur, 668; and sacro-iliac disease, 668, 677; stages of disease, 668; shape of, 614; dislocations of, 587; congenital, 350; unreduced, 555; excision of, 676, 701
Hodgen's splint, 469, 482
Holt's dilator, 1285
Homatropin, 814
Horns, 133; on scalp, 737; on eyelids, 843
Horsley: on intracranial tumours, 757; on tetanus, 110; on tumours of spinal cord, 812
Hospital gangrene, 51
Howse on gastrostomy, 1008
Humerus: dislocation of, 566; reduction of, 571; unreduced, 576; fracture of, 430; in reducing dislocation, 577; ununited, 389; separation of epiphysis of, 432, 442, 580
Humphry, 590, 689
Hunter's canal, ligature in, 298; method of ligature, 259
Hutchinson: amputation in gangrene, 50; massage in intestinal obstruction, 1073; on ostitis deformans, 534
Hydatid: of brain, 758; breast, 1359; kidney, 1151; liver, 1095; of Morgagni, 116; and ovarian cyst, 1332
Hydramnios, 1330
Hydrarthrosis, 609, 618, 643
Hydrencephalocele, 706
Hydrocele, 1316; diagnosis of, 1301; of hernial sac, 1012; of neck, 311, 951
Hydrogen gas, injection of, 1004
Hydronaphthol, 161
Hydronephrosis, 1147; spurious, 1143; and ovarian cyst, 1332
Hydrophobia, 109
Hydrophobic tetanus, 105
Hydrops antri, 882; articuli, 609, 618, 643
Hydrosalpinx, 114, 1322
Hygroma, congenital, 119, 127, 311, 951
Hyoid, fracture of, 941
Hyolingual canal, 118; cysts, 952
Hyperabduction in reducing dislocation, 575
Hyperæmia of brain, 745
Hyperæsthesia of larynx, 934; in spinal injury, 777; in railway injury, 788
Hypermetropia, 815
Hyperostosis, 516, 520
Hyperplasia and inflammation, 18
Hyperpyrexia in tetanus, 108
Hypertrophic catarrh of nose, 864; lupus, 857
Hypertrophy of bone, 491; breast, 1352; congenital, 312; tonsils, 908
Hypnotic sleep, 788
Hypodermic use of mercury, 99
Hypospadias, 1298
Hypostatic congestion in spinal injury, 799
Hysterectomy, 1343
Hysteria and hip-disease, 667; in railway accidents, 788
Hysterical dysphagia, 976

I

Ice-bag, for checking inflammation, 416
Ichthyosis of tongue, 895
Idiopathic aneurysm, 249
Ileus paralyticus, 1032, 1057, 1067
Iliac abscess, 794; aneurysm, 275; common artery, ligature of, 294; external, 296; internal, 295
Immediate treatment of talipes, 359
Immovable splints, 408
Impacted calculus in ureter, 1157; in urethra, 1258
  fracture, 394
Impaired mobility in hip-disease, 665
Imperfect repair after dislocation, 554
Impermeable stricture, 1282
Impetigo, 184
Implantation of intestine, 1091
Impulse, loss of, in strangulation, 1023
Incised wounds, 150
Incisions: on hand, 341; to relieve tension, 48, 55; in hydrocele, 1320
Incontinence in spinal injury, 782; after fistula, 1130; of urine, 1192
Incubation of hydrophobia, 109; of syphilis, 81, 87; of tetanus, 106; of tubercle, 75
Indian operation for rhinoplasty, 861
Induration of chancre, 82; lobular, of breast, 1357
Inequality of limbs in scoliosis, 802
Infantile hernia, 1035; hydrocele, 1318; paralysis, 361, 364; as a cause of fracture, 377; simulating rickets, 530; pseudoparalysis, 96; umbilical hernia, 1046
Infarcts, 246; in pyæmia, 58
Infected wounds, 160, 168
Infective arteritis, 234; softening of thrombi, 244
Inferior maxilla, fracture of, 419
  dental nerve in fracture, 422; section of, 330
Infiltrating scirrhus, 1363
Inflammation, 7; of bone, 491; brain, 741, 754; in burns, 178; chronic, 17; diffuse, of neck, 948; in fracture, 402, 416; of hernia, 1018; and hyperplasia, 18; of joints, 608; of meninges, 741; due to poisons, 53; phlegmonous, 51;

after sprains, 551 ; of tongue, 893 ; temperature in, 9 ; treatment of, 12 ; in wounds, 152, 157
Infractions in rickets, 530
Ingrowing toe-nail, 208
Inguinal aneurysm, 275 ; canal in hernia, 1040 ; colotomy, 1083 ; hernia, 1033 ; radical cure of, 1037 ; tumours, diagnosis of, 1301
Inhalations, 925
Injection in delayed union of bone, 390 ; gonorrhœa, 1269 ; hydrocele, 1319 ; hernia, 1039 ; hydrops articuli, 645 ; piles, 1110 ; synovitis, 618 ; syphilis, 99
Injury, as a cause of arthritis, 610 ; histological changes after, 4
Innominate aneurysm, 261, 266 ; ligature, 282
Inoculation of tubercle, 75
Insanity, traumatic, 735
Inspection in intestinal obstruction, 1071
Instrumental compression, 258
Insufflation in intussusception, 1062 ; of larynx, 925
Intention, healing by first, 151
Intercostal arteries, wounds of, 988
Interdental splints, 420
Intermaxilla, treatment of in harelip, 852
Intermediary amputation, 1371
Intermittent fever, 11
Internal derangement, 599
  ear, diseases of, 922
  hæmorrhage, 213
  hæmorrhoids, 1106
  hernia, 1050
  iliac, aneurysm of, 276 ; ligature of, 295
  mammary, ligature of, 289 ; wounds of, 989
  pudic, hæmorrhage from, 220, 1222
  strangulation, 1049, 1056
  urethrotomy, 1284
Interrupted suture, 166
Intersigmoid fossa, 1050
Interstitial absorption of neck of femur, 464
  condensing ostitis, 520
  emphysema, 982
  fibroids, 1340
  gestation, 1324
  keratitis, 97, 827
  syphilitic osteomyelitis, 515
Intertrigo, 185
Intestinal anastomosis, 1090
  implantation, 1091
  obstruction, 1049, 1063 ; symptoms of, 1068 ; treatment of, 1072
  strangulation, 1059 ; evacuation in, 1060
Intestines, inflation of, 1004 ; in hernia, 1030 ; malignant disease of, 1065 ; operations on, 1079 ; resection of, 1087 ; strangulation of, 1020 ; stricture of, 1004 ; wounds of, 1006
Intoxication, septic, 21
Intra-articular anchylosis, 691 ; fracture, 383 ; of femur, 456
Intracranial hæmorrhage, 727 ; abscess, 750 ; suppuration, 746 ; tumours, 757
Intracystic growths, 115
Intralaryngeal operations, 933
Intraparietal sac, 1012, 1026
Intrapelvic abscess in hip-disease, 667, 676
Intrathoracic aneurysm, 265
Intrauterine fracture, 376
Introduction of foreign bodies in aneurysm, 263
Intubation of larynx, 960 ; œsophagus, 980
Intussusception, 1052 ; treatment of, 1061 ; chronic, 1067 ; treatment of, 1073
Inunction of mercury in syphilis, 99
Inversion as an aid to taxis, 1024
Involution cysts, 115
Iodide of potash : coryza, 100 ; eruptions, 100, 190 ; in syphilis, 100 ; in aneurysm, 257 ; in ostitis, 499
Iodine in goître, 968 ; in hydrocele, 1319
Iodoform in abscesses, 32, 657 ; in fractures, 414 ; hydrocele, 1320 ; after removal of tongue, 906 ; in syphilitic ulcers, 198 ; in wounds, 161 ; poisoning, 161
Iridectomy, 847 ; for glaucoma, 834
Iris, diseases of, 829 ; in syphilis, 86, 828 ; after cataract, 849 ; in rheumatism, 830 ; prolapse of, 819
Iron in erysipelas, 65
Irreducible hernia, 1016 ; umbilical, 1016, 1046
Irrigation of joints, 549, 628 ; of wounds, 160
Irritability of bladder, 1190 ; brain, 721, 745 ; urethra, 1280
Irritants, classification of, 1 ; causing gangrene, 40 ; effect of, 7
Irritation, sympathetic, of eye, 820
Irritative fever, 10
Ischiorectal abscess, 1122
Italian operation for rhinoplasty, 862
Itching of scars, 174
Ivory exostoses, 125, 537

J

Jack-towel in extension, 557, 574
Jacobson, 702
Jaws, closure of, 882 ; dislocation, 561 ; excision, 889 ; of condyle of, 883 ; fracture of, 419 ; necrosis of, 500, 879 ; resection, 869 ; tumours, 884
Joints, contusions of, 550 ; excision of, and arthrectomy, 656 ; compound fractures into, 417, 443, 452 ; dislocations of, 552 ; unreduced, 554 ; examination of, 612 ; hæmorrhage into, 233 ; inflammation of, 608 ; of ankle, 685 ;

elbow, 683 ; hip, 659 ; knee, 677 ; sacro-iliac, 676 ; shoulder, 686 ; wrist, 688 ; injuries of, 546 ; in fractures, 402 ; of elbow, 438, 443 ; of knee, 473, 479 ; of shoulder, 435 ; of wrist, 452 ; irrigation of, 628 ; loose bodies in, 639, 688 ; shape of when inflamed, 614, 617, 623 ; sprains of, 550 ; of spine, 771 ; wounds of, 546
Jordan Lloyd's elastic strap, 1375
Joubert's suture, 1088
Jugular vein, ligature of, in pyæmia, 753 ; wound of, 939
Junker's inhaler, 1384
Jury-mast, 798

K

Kangaroo tendon, 223
Keegan on lithotrity, 1215
Kelotomy, 1028
Keratitis, interstitial, 97, 827
Kerato-iritis, 830
Kerion, 206
Key-note position in scoliosis, 807
Key's staff, 1218
Kidney, abnormalities of, 1140 ; calculus in, 1152 ; differentiation of secretion of, 1168 ; examination of, 1150 ; floating, 1141 ; inflammation of, 1159 : injuries of, 1142 ; operations on, 1169 ; tumours, 1150
Knee-joint, amputation through, 1377 ; arthrectomy of, 658 ; aspiration, 476 ; in Charcot's disease, 648 ; dislocation of, 598 ; drainage of, 628 ; excision of, 703 ; in fractured patella, 479 ; fracture into, 473, 479 ; internal derangement of, 599 ; irrigation of, 628 ; shape of in synovitis, 614, 617 ; Thomas' splint for, 683 ; tubercle of, 678
Knock-knee, 371
Knott, 600
Kocher, removal of tongue, 905 ; on fractured patella, 473
Koeberle, resection of intestine, 1086
Kœnig, 651
Kraske, on excision of the rectum, 1137
Krohne, modified Thomas' splint, 798
Kussmaul, 1059
Kyphosis, 801

L

Labial cysts, 884, 1348
Lacerated wounds, 151
Lachrymal obstruction, 842
Lactic acid in lupus, 193
Lamellar cataract, 832
Laminated clot, 251, 256
Landry, 110
Langenbeck, 701 ; nasal polypi, 869 ; operation for nose, 862 ; resection of maxilla, 870
Laparo-colotomy, 1083
Laparotomy in intestinal obstruction, 1073 ; strangulation, 1059 ; intussusception, 1063 ; peritonitis, 1078 ; perityphlitis, 1075
Laryngeal growths, removal of, 933 ; diagnosis, 963
Laryngitis, erysipelatous, 64 ; from scald, 946 ; in syphilis, 84, 92
Laryngotomy, 953 ; preliminary, 904
Laryngo-tracheotomy, 959
Larynx, diseases of, 924 ; disorders of sensation, 934 ; foreign bodies in, 942 ; fracture of, 941 : intubation of, 960 ; operations on, 953 ; paralysis, 934 ; perichondritis, 929 ; phthisis in, 929 ; syphilitic disease of, 931 ; tumours, 931 : wounds, 938
Latent calculus, 1155, 1208
    fracture of spine, 776
Lateral curvature of spine, 802
    lithotomy, 1217
    sinus, thrombosis of, 752
Lawn-tennis leg, 332
Lead in eczema, 186
Leather splint for fractured patella, 478
Leg, amputation of, 1377
    chronic ulcer of, 199, 241 ; fracture of, 480, 488
Leiter's coils, 13 ; panelectroscope, 1271
Lembert's suture, 1086
Length of mesentery in hernia, 1010
Lengthening in hip-disease, 665
Lens, dislocation of, 821
Leontiasis ossea, 535
Lepra cells, 103
Leprosy, 102 ; of the face, 858
Leucocytes, action of in repair, 5
Leucoma, 895
Leucoplakia, 895
Lichen, 188 ; in syphilis, 84
Lids, granular, 823
Ligaments, division of, in talipes, 358 ; strain of spinal, 771
Ligature of abdominal aorta, 293 ; in aneurysm, 259, 264 ; of arteries, 222 ; after compression, 258 ; for inflammation, 416 ; of artery and vein, 229 ; of anterior tibial, 300 ; of axillary, 289 ; of brachial, 290 ; carotid, 233 ; of common iliac, 294 ; dorsalis pedis, 301 ; of external iliac, 296 ; facial, 286 ; femoral, 297 ; gluteal, 295 ; jugular vein in pyæmia, 753 ; internal mammary, 289 ; internal iliac, 295 ; innominate, 282 ; lingual, 285 ; popliteal, 298 ; posterior tibial, 299 ; for piles, 1112 ; radial, 292 ; subclavian, 286 ; temporal, 286 ; varicose veins, 242 ; vertebral, 288
Lime in rickets, 531
Limping in hip-disease, 661
Line of demarcation, 41
Linear osteotomy in ostitis, 500
Lingual artery, ligature, 285 ; nerve, operations on, 900
Lip, malformations, 850 ; epithelioma, 860

- Lipoma, 121; congenital, 769; myxomatous, 122; nasi, 855; of tongue, 900
- Liquefaction of tubercular deposit, 77
- Lisfranc's amputation, 1381
- Lister's dressings, 33, 161; excision of wrist, 699; tourniquet, 218; sounds, 1283
- Liston's splint, 465
- Lithotomy, lateral, 1217; accidents in, 1222; cellulitis after, 52; prognosis of, 1222; median, 1224; suprapubic, 1226; compared with lithotrity, 1228
- Lithotrity, 1210; accidents in, 1214; at different ages, 1215; difficulties in, 1216; compared with lithotomy, 1228
- Littre's hernia, 1022; operation, 1083
- Liver, abscess of, 1093; hydatids, 1095; operations on, 1094; rupture, 1003
- Lobular induration of breast, 1357
- Localisation, cerebral, 763
- Locality of pain in hip-disease, 661
    - of leprosy, 102
- Lonsdale's clamp, 422
- Loose cartilages in joints, 639, 688
- Lordosis, 663, 801
- Loreta's case of abdominal aneurysm, 263, 275
    - operation, 1009
- Lucas, 600
- Lumbago, 772
- Lumbar abscess, 794; colotomy, 1081; hernia, 1049; vertebræ, fracture of, 782
- Lund's oil, 1260
- Lungs, foreign bodies in, 943, 993; hernia, 992; injuries of, 982, 986
- Lupus, 74, 190; of face, 857; hypertrophic, 857; of larynx, 930; rectum, 1120; of tongue, 899
- Lupus erythematosus, 193
- Luschka's gland, 769
- Luxatio erecta, 566
- Lymph, organisation of, 152
- Lymphadenitis, 304; in syphilis, 83
- Lymphadenoma, 131, 309
- Lymphangeioma, 119, 311, 951
- Lymphangeiectasis, 311
- Lymphangitis, 302
- Lymphatic glands, diseases of, 302; in erysipelas, 64; inflammation of, in neck, 948; tumours of, 308
- Lymphoma, 309
- Lymphorrhœa, 313
- Lymphosarcoma, 131, 310

M

- MacCormac, 686
- MacEwen, 392, 725; chisels, 373; drainage-tubes, 169; intubation-tubes, 960; radical cure of hernia, 1040
- MacGill, 392, 1249
- McIntyre splint, 469
- Macrocheilia, 312
- Macroglossia, 127, 312, 892
- Macrostoma, 850
- Macule, 183
- Madelung, 1082
- Maisonneuve's urethrotome, 1285
- Makins' clamp, 1087; artificial anus, 1093
- Malar bone, fracture of, 419
- Malformations of bladder, 1183; of breast, 1352; of face, 850; of rectum, 1101; of tongue, 892
- Malgaigne's hooks, 476; operation for hare-lip, 851
- Malignancy, 132
- Malignant disease of intestine, 1065; œdema, 67; pustule, 67
- Malingering, ulcers in, 200
- Malnutrition after sprain, 551
    - as a cause of non-union, 389
- Malposition of testis, 1303
- Malum coxæ senile, 637, 644
- Mal-union of fracture, 383
- Mammary abscess, 1355
    - gland. *See* Breast
    - glandular tumour, 1360
    - ligature of internal, 289
- Mammilla. *See* Nipple
- Manipulation in aneurysm, 262; in dislocation of the spine, 783; in Colles' fracture, 449; in lateral curvature, 808; in reduction of dislocation, 557, 571
- Manual examination of rectum, 1071, 1102
- Marriage in syphilis, 94, 102
- Marsh, 600, 655
- Martin's bandage, 199
- Massage in lateral curvature, 808; in inflammation, 19; in intestinal obstruction, 1073; in nerve-injury, 320, 325; in œdema, 248; in sprains, 551; in tenosynovitis, 341; in writer's cramp, 336
- Mastitis, 1354; chronic interstitial, 1357
- Mastoid cells, suppuration in, 749, 752, 920
- Maxilla, fracture of, 419; dislocation of, 561; necrosis of, 500
- Measurement for truss, 1015
- Mechanical stimulation in delayed union, 390
    - support in caries, 796; curvature, 809
- Meckel's diverticulum, 117, 1051
    - ganglion, excision of, 329
- Median lithotomy, 1224; compared with lateral, 1225
- Mediastinal abscess, 993; in Pott's disease, 792
- Medulla, drainage of, 506; in fractures, 381
    - oblongata, pressure on in caries, 791
- Medullary carcinoma, 139
    - lesions of brain, 723, 759
    - sarcoma of bone, 541
- Meibomian cyst, 843
- Melanosis, 130
- Melanotic sarcoma, 130; of iris, 829; choroid, 840
- Melon-seed bodies, 339, 347, 688

Menière's disease, 923
Meningeal artery, rupture of, 727
Meningitis, 741; of cord, 809; consecutive to otitis, 749, 921; disease of spine, 792; suppurative, 746
Meningocele, 706, 766
Meningomyelitis and railway spine, 789, 811
Meningomyelocele, 766
Mental emotion as a cause of shock, 141
Mercier's prostatotomy, 1248
Mercurial necrosis, 501; stomatitis, 877, 879; teeth, 828; and cataract, 832
Mercury in inflammation, 19; in iritis, 831; in syphilis, 98
Mesentery, length of, 1010; prolapse of, 1011
Metacarpal bones, fracture of, 451; tubercular disease of, 524; dislocation of thumb, 585
Metastasis in erysipelas, 64
Metastatic abscesses, 28, 58; orchitis, 1304
Meteorism in obstruction, 1068
Methylene bichloride, 1385
Mickulicz, 686; on peritonitis, 1078
Microbes causing gangrene, 40; non-infective, 20; pathogenic, 23
Micrococcus cyaneus, 25
Micro-organisms of suppuration, 23
Microsporon furfur, 204
Micturition in fracture of spine, 780
Middeldorpf's triangle, 437
Middle ear, disease of, 919
    meningeal, rupture of, 727, 732
Milk cysts, 1360
Mind-blindness in lesions of cortex, 725
Mobility as a sign of fracture, 394; in hip-disease, 666
Mocmain truss, 1013
Moist gangrene, 39, 45
Moles, 201
Mollities ossium, 536; and fracture, 378
Molluscum contagiosum, 202, 844; on face, 859
    fibrosum, 120, 127
Monoplegia, 722
Monospasm, 722
Morbus coxæ, 659
Morgagni, hydatid of, 116
Morrant Baker, 648; on excision of tongue, 903
Morris, 590; bitrochanteric measurement, 457
Mortification, causes of, 39
Morton's fluid, 768
Mouth, inflammation of, 875; lupus, 191; malformations, 871; tumours of, 884: wounds of floor of, 938
Movable kidney, 1141
    splints, 408
Movement as a cause of non-union, 389
Mucocele, 842
Mucous cysts, 114; of mouth, 884, 887; tongue, 900
    membrane, grafting of, 156
Mucous patches, 84; on tongue, 898
    polypi, 867
Mucus in urine, 1179
Müller's ducts, 116
Multilocular cysts of jaws, 888; ovary, 1326
Multiple periostitis, 506
Mumps, 911; and orchitis, 1304
Muscæ volitantes in myopia, 817
Muscles, rupture of abdominal, 1002
    functional disorders of, 334
    ossification of, 332
    paralysis of ocular, 840
    rupture of, 332, 1002
Muscular asthenopia, 841
    atrophy, 331, 335; after fractures, 403; in arthritis, 615, 665; after nerve-section, 316; sprains, 331
    contraction as a cause of fracture, 380, 474; of displacement, 394; after nerve-injury, 322; in arthritis, 615
    contracture, 337
    spasm after head injuries, 722; in swallowing, 976; in tetanus, 107; in stumps, 1382
    strain, 772; in spinal injury, 771
    twitching in fracture of spine, 781
    wasting as a cause of curvature, 802
Musculospiral, paralysis of, 316, 438
Mydriasis, traumatic, 820
Myelitis, 810
Myeloid sarcoma, 129; of bone, 542
Myofibroma, 126
Myolipoma, congenital, 769
Myopia, 816
Myosarcoma, 131
Myositis, 337
Myxœdema, 965
Myxoma, 122
Myxomatous carcinoma, 139
    lipoma, 122
Myxosarcoma, 129

N

Nævi, 126, 200, 231; of eyelid, 844; neck, 951; of scalp, 737; tongue, 899
Nails, affections of, 207; after nerve-section, 317; ingrowing, 208
Narcotics in neuritis, 325
Nares, tumours of, 867
Nasal bones, fracture of, 418; inflammation of, 865
Nasopharyngeal polypi, 868
Nathan Smith's splint, 469, 482
Natiform skull, 518
Neck, cellulitis of, 53, 948; cysts of, 95, 117; dislocation of tendons of, 334; inflammation of glands of, 948; nævi, 951; tumours, 951; wry neck, 949; wounds of, 937
Neck of femur, absorption of, 464; angle of, 456; atrophy, 458; fracture, 456; diagnosis, 463

Necrogenic lupus, 191
Necrosis, 492; acute, 501; after amputation, 512; coagulation, 24; of cranium, 740; of cartilage, 610; of jaws, 879; mercurial, 501; of nasal bones, 866; of last phalanx, 340; phosphorus, 500; quiet, 494, 498; of scalp wounds, 710; of stumps, 1382
Needle, exploring, 30
    for cataract, 848
Nélaton's line, 457; operation for harelip, 851; enterostomy, 1080
Nephralgia, 1154
Nephrectomy, 1171
Nephritis, 1158; causing suppression, 1145
Nephrolithotomy, 1169
Nephrorrhaphy, 1142
Nephrotomy, 1169
Nerve-bulb, 316
Nerves, anastomosis of, 316; compression of, 217, 318, 401; contusions of, 318; evulsion, 329; grafting, 321; inflammation of, 323; injury of cranial nerves in fractures, 717, 729; irritation as a cause of gangrene, 40; of tetanus, 105; in leprosy, 104; in syphilis, 92; regeneration of, 315; wounds of, 315
Nerve-section in tetanus, 108; as a cause of anchylosis, 692
Nerve-splitting in leprosy, 105
Nerve-stretching, 319, 325; in leprosy, 105; tetanus, 108
Nerve-suture, 319
Nervous system, diseases of, in arthritis, 611, 644; as a cause of fracture, 378; in syphilis, 104; in railway accidents, 788
Neuber's drainage-tubes, 169
Neuralgia, 326; of scars, 174; stumps, 1382; testis, 1303; nerve-section for, 813
Neurenteric canal, cysts from, 118
Neuritis, 323; as a cause of tetanus, 106; optic, 835
Neurofibroma, plexiform, 120
Neuroma, 127, 330
Night-blindness, 838
Nipple, affections of, 1352; Paget's disease of, 1353; retraction of, 1366
Nitric acid in piles, 1110; in prolapse, 1116
Nitrous oxide gas, 1383
Nocturnal incontinence, 1192
Nodes, 492, 521; Parrot's, 518, 740
Nodosity of joints, 637
Nodular scirrhus, 1363
Noma, 856
Non-union of fracture, 387
Nose, hæmorrhage from, 862; hypertrophy of, 855; foreign bodies in, 853; malformations of, 861; plastic surgery of, 861; syphilitic affections of, 92, 95
Nostrils, plugging, 862
Nothnagel's test, 1088
Nuclear cataract, 832
Nuhn's gland, 114, 885
Nussbaum, 336, 392
Nutrition, influence of, in repair, 3; lesions in spinal injury, 777, 810
Nystagmus, 822

O

Obesity and ovarian cysts, 1330
Oblique illumination of eye, 814
Obsolescence of tubercle, 77
Obstructed hernia, 1018
    lymphatics, 313
Obstruction, intestinal, 1049, 1063; diagnosis of, 1070; symptoms, 1068; treatment, 1072; after ovariotomy, 1338
Obstruction of lachrymal duct, 842
    of ureter, 1146
    of veins, 244
Obturator artery, division of, 1045
    hernia, 1047
    internus in dislocation of hip, 590
Occlusion of vessels, effects of, 215
Ocular muscles, paralysis of, 840
Odontomata, 886
O'Dwyer's tubes, 960
Œdema, acute, of neck, 948; in fractures, 401; malignant, 67; solid, 16, 312; of scrotum, 1300
Œdematous piles, 1106
Œsophagostomy, 980
Œsophagotomy, 975
Œsophagus, epithelioma of, 977; foreign bodies in, 974; inflammation of, 976; injuries of, 973; paralysis of, 976; stricture of, 977
Ogston, 23, 352, 368, 374
Olecranon, fracture of, 449
Olfactory bulbs, injury to, 729
Omentum, grafting, 1088; injuries of, 1005; strangulation of, 1021; treatment of, 1030
Onychia, 207
Oöphorectomy, 1323; and osteomalacia, 537
Operations on the eye, 845; subcutaneous, 171; in shock, 143
Ophthalmia, catarrhal, 821; diphtheritic, 823; gonorrhœal, 823; neonatorum, 822; purulent, 822; sympathetic, 820
Ophthalmoplegia, 92, 97, 840
Ophthalmoscope, 814
Opium in aneurysm, 258; coma and concussion, 726; in delirium tremens, 145; in obstruction, 1072; strangulation, 1058; intussusception, 1062; peritonitis, 1078; phagedæna, 200; senile gangrene, 50
Opisthotonos, 105
Optic disc, affections of, 835; atrophy, 836; nerve, injury to, 729
Orbit, cellulitis of, 53
Orbital aneurysm, 270
    tumour, pulsating, 244

Orchitis, gouty, 1310; metastatic, 1304; in mumps, 911; syphilitic, 1307; suppurative, 1310; tubercular, 1308
Ord on arthritis, 632
Organisation of extravasated blood, 5, 149; of granulations, 154; lymph, 152, thrombi, 243
Organisms, classification of pathogenic, 23
Origin of calculi, 1203
Ormsby's inhaler, 1383
Os magnum, dislocation of, 584
Osseous anchylosis, 691; of hip, 676
nodes, 515
Ossification of callus, 382; in rickets, 516
Ossifying myositis, 338
Osteo-aneurysm, 345
Osteo-arthritis, 637; and loose cartilages, 689; after dislocations, 559
Osteocopic pains, 86, 514
Osteoid tissue in rickets, 516
Osteoma, 125, 537; of skull, 740
Osteomalacia, 536; skull in, 535; as a cause of fracture, 378
Osteomyelitis, 492: acute, 501, 512; after amputation, 513; syphilitic, 515
Osteophytes, 638
Osteoplastic resection of ankle, 686
Osteo-sarcoma, 129
Osteo-sclerosis, 493, 516; rheumatic, 522
Osteotomy, 373; for anchylosis, 694; in ostitis, 500, 507
Ostitis, 491; of cranium, 739; as a cause of cerebral abscess, 750; of fracture, 378; of delayed union, 389; deformans, 18, 533; of femur and hip disease, 668; of jaws, 879; in knee-joint disease, 679; in inflammation of joints, 610; of nose, 865; in syphilis, 91, 97, 514; tubercular, 523, 624; of vertebræ, 789
Othæmatoma, 917
Otis's urethrameter, 1287; urethrotome, 1286
Otitis media, 919; as a cause of meningitis, 748; suppurative, 754
Ovaries, cysts of, 118; inflammation of, 1322; pedicle, twisting of, 1333; tumours of, 1326
Ovariotomy, 1334
Over-extension as a cause of anchylosis, 692
Overflow of urine, 1109, 1192; in enlarged prostate, 1242; in spinal injury, 780
Overgrowth, 312, 350
Oxalate of lime, 1175
Ox aorta, ligature of, 223
Ozæna, 864, 866

P

Pads in fractures, 408
Page, railway accidents, 787
Paget's disease, 185, 1353
Pain in fractures, 395; in hernia, 1022, 1055; in hip-disease, 661; in obstruction, 1068
Painful subcutaneous tubercle, 120
Palate, cleft, 871; deviation of, after injury to brain, 730; wounds of, 875
Palatine arteries, hæmorrhage from, 220
Palliative treatment of epithelioma of tongue, 902
Palmar arch, wound of, 220; fascia, contraction of, 344; section of, 345; ganglion, 342; tendon-sheaths, 341
Palpation in obstruction, 1071
Pancreas, cysts of, 1099
Panelectroscope, 1271
Pannus, 824
Papillary cysts, 115, 1328
synovitis, 509, 639
Papillitis, optic, 836
Papilloma, 133; of bladder, 1230; gums, 884; larynx, 932; tongue, 900
Papule, 183
Paracentesis, thoracis, 995; pericardii, 1000
Paræsthesia of larynx, 934
Paraffin as a splint, 409
Paralysis, ascending, of Landry, 110; cortical, 723; diphtheritic, 841; as a cause of fracture, 377; infantile, 361, 364; of larynx, 934; after nerve-section, 316; of muscles of eye, 840; of œsophagus, 976, 978; reflex, 322; of shoulder, 557, 570; spastic, 744; spinal 794
Paraphimosis, 1299
Paraplegia in spinal disease, 794, 880; in injury, 776
Parasitic fœtus, 118, 770
Parenchymatous goître, 966
prostatitis, 1253
Parker, 354; on tracheotomy, 954; suction cannula, 955
Paroöphoron, 116, 1328
Parotid, division of duct, 854; inflammation of, 911; tumour of, 123, 131, 912; bubo, 23
Parovarian cysts, 116
Parrot's nodes, 96, 518, 740
pseudo-paralysis, 519
Parulis, 880
Passive clot, 251
motion in arthritis, 619; after dislocations, 559; excision, 696, 701; sprains, 552; synovitis, 619
Pasteur, 111
Patella, dislocation of, 597; fracture of, 473
Pathogenic organisms, classification of, 23
Pedicle of ovarian tumour, 1333; in hysterectomy, 1345
Pedunculated hæmorrhoids, 1108
Pegging arch of foot, 368; in delayed union, 391
Pelvic cellulitis, 52, 1123
Pelvis, fracture of, 453; in rickets, 528
Pemphigus, 189; in syphilis, 95
Penetrating wounds of abdomen, 1005

Penis, amputation of, 1299; epithelioma of, 1299; gangrene, 1292; malformations, 1298
Perchloride of iron, in goître, 970; in erysipelas, 65
Percussion in intestinal obstruction, 1071
Perforating ulcer, 317, 647
Perforation of appendix, 1075
Periadenitis, 304
Periarteritis, 234; as a cause of aneurysm, 250
Pericardium, paracentesis of, 1000; wounds, 987
Perichondritis of larynx, 929
Pericranium, nodes on, 515; separation, 710
Perineal abscess, 1294; cystotomy, 1236; dislocation, 596; fistula, 1296; hernia, 1048; prostatectomy, 1249
Perinephritis, 1166
Perineum, rupture of, 1350
Periosteal abscesses of jaw, 881; changes in rickets, 526; cysts, 882, 888; nodes, 514; sarcoma, 541
Periosteum, division of, in inflammation, 506; function of, 380; grafting, 392; preservation after excision, 696
Periostitis, 492; acute, 501; of femur and hip disease, 668; of last phalanx, 340; syphilitic, 86, 102; multiple, 506
Periphlebitis, 246
Periproctitis, 1122
Peritomy, 825
Peritonitis, 1076; after taxis, 1027; herniotomy, 1031; after ovariotomy, 1338; and strangulation, 1057
Perityphlitis, 1074; and hip-disease, 668; distinguished from strangulation, 1057
Peronæi tendons, displacement of, 324
Petit's tourniquet, 217
Phagedæna, 45, 50, 101; and chancroid, 80
Phalanges, enchondroma on, 124; strumous nodes, 524
Phalanx, necrosis of last, 340
Pharyngitis, erysipelatous, 64
Pharyngocele, 953, 973
Pharyngotomy, subhyoid, 959
Pharynx, foreign bodies in, 974
Phelps, 350
Phimosis, 1298
Phlebitis, 244, 247; syphilitic, 86
Phlegmasia alba dolens, 313
Phlegmonous inflammation, 51
Phlyctenulæ, 825
Phosphates in urine, 1175
Phosphorus necrosis, 500, 879
Phthisis and fistula, 1130
Pick's bandage, 428
Pigeon-breast, 528
Pigmentation in syphilis, 85
Piles. *See* Hæmorrhoids
Pinning in fracture of patella, 477
Pirogoff's amputation, 1378
Pirrie, 1379
Pisiform bone, dislocation of, 585
Pityriasis, 184; versicolor. *See* Tinea
Placenta, in ectopic gestation, 1325
Plantar fascia, section of, 357
Plantaris, rupture of, 332
Plaster splints, 409, 484; in caries of spine, 769; in fracture, 783; in talipes, 356
Pleura, rupture of, 986; inflammation, 994
Pleurosthotonos, 105
Plexiform neurofibroma, 120
Plugging nostrils, 864
Pneumocele, 992
Pneumonia, 986, 994; in burns, 178; after operations on tongue, 906; wounds of neck, 940
Pneumonotomy, 1000
Pneumothorax, 990
Poisoned wounds, cellulitis after, 52
Poisons, chemical, as cause of inflammation, 52
Polar cataract, 822, 831
Polk's method of collecting urine, 1168
Polymastia, 1352
Polymorphism in syphilis, 85
Polypi, 120; of antrum, 881; bladder, 1230; ear, 920; mucous, 867; nasopharyngeal, 868; rectum, 1117
Pompholyx, 190
Poore, Vivian, 336
Popliteal aneurysm, 278; rupture, 255; cysts, 348, 644; artery, ligature of, 298; in fractures, 400, 471
Poroplastic jacket, 796; splints, 408, 484
Porrigo, 184
Position in arthritis, 615; fractures, 406; in inflammation, 13; in wounds, 163
Posterior staphyloma, 817
    tibial artery, ligature of, 299; in fractures, 400, 488; wound of, 221
    tibial tendon, division of, 357
Pott's disease, 789; fracture, 486, 602; as a cause of flat-foot, 366; on fractures of the femur, 468; puffy tumour, 712, 747, 751; splint, 482
Præmaxilla, treatment of, in hare-lip, 852
Pregnancy in fibroids, 1341; and ovarian cysts, 1330; and osteomalacia, 536
Presbyopia, 818
Pressure, 13; in arthritis, 616, 622; in aneurysm, 252, 267; hæmorrhage, 219; in wounds, 163
Priapism in fracture of spine, 780
Primary amputations, 412, 1371
    hæmorrhage, 210
    operations in shock, 143
Probangs, 975
Proctitis, 1119
Proctotomy, 1133
Progressive multiple neuritis, 324
    myositis, 337
Prolapse of anus, 1114; kidney, 1144; iris, 819; mesentery, 1011; piles, 1107; rectum, 1114; excision of, 1117
Proliferous cysts, 115, 1361
Proptosis, 845

Prostate, calculi in, 1255; enlargement of, 1238; and atony, 1242; and catheterism, 1244; inflammation of, 1251; gouty, 1253; suppuration in, 1254; tumours of, 1250
Prostatectomy, 1249
Prostatitis, retention in, 1195
Prostatotomy, 1248
Provisional callus, 381
Prurigo, 189
Pruritus ani, 1118
Psammoma, 132
Pseudo-arthrosis, 387
Pseudo-glioma, 838
Pseudo-paralysis, 96; of infants, 519; in rickets, 530, 532; in strains, 772
Pseudo-strangulation, 1057
Psoas abscess in Pott's disease, 794, 799
  inflammation of, and hip-disease, 668
Psoriasis, 187; in syphilis, 84, 95, 101
Psorosperms, 1354
Ptomaines, 20
Pubic dislocation, 595
Pudendal hernia, 1048
Pudic aneurysm, 276; artery, hæmorrhage from, 220
Puerperal arthritis, 630
Pulleys for reduction of dislocation, 558, 596
Pulmonary congestion after fracture, 398
Pulsating bronchocele, 966
  orbital tumour, 844
  sarcoma and aneurysm, 255, 276, 544
  tumour of bone, 545
Pulsation, expansile, 252; recurrent, 259, 279; of vessels in glaucoma, 834
Pulse in aneurysm, 252, 267
Puncture of bladder, 1196; of kidney, 1169; of testis, 1306; in delayed union, 390
Punctured fracture of skull, 713
  wounds, 151, 171; hæmorrhage from, 221, 225; of neck, 939
Pupil in injuries of the sympathetic, 778
Purgatives in peritonitis, 1078
Purpura and rickets, 532
Purulent exudation, 8; synovitis, 509
Pus, 24; in urine, 1179
Pustule, 183; malignant, 67
Pyæmia, 56; and cerebral abscess, 751
Pyæmic arteritis, 234; phlebitis, 248; arthritis, 629; suppuration in tendon-sheaths, 340
Pyelitis, 1161; calculous, 1156; suppurative, 1162; tuberculous, 1162
Pylorectomy, 1009, 1090
Pyogenic membrane, 24, 496
  organisms, 23, 56; in tubercle, 76
Pyonephrosis, 1164
Pyosalpinx, 1322
Pyramidal cataract, 822, 831
Pyrogenous agents, 10, 147

Q

Quiet necrosis, 494, 498
Quill suture, 164
Quilt suture, 166
Quinsy, 908

R

Rabies, 109
Radial artery, ligature of, 292
Radical cure of hernia, 1037, 1045; of varicose veins, 241
Radius, dislocation of, 582; fracture, 443; subluxation, 583; and ulna, dislocation of, 579
Railway accidents, amputations in, 411
  spine, 773, 787, 811
Rand, distinction of coils of intestine, 1059
Ranula, 114, 884
Rapid coagulation in aneurysm, 261
Rarefying ostitis, 492; of cranium, 739
Rat-tail pads, 1014
Raynaud's disease, 44
Reaction in concussion, 719
Readjustment in delayed union, 390
Rectal lever, Davy's, 218
Rectovaginal fistula, 1349
Rectum, atony of, after piles, 1114; epithelioma of, 1134; examination of, 1071, 1102; excision, 1136; fistula, 1126; inflammation of, 1119; lupus, 1120; malformations, 1101; plugging for hæmorrhage, 1113; polypus, 1117; prolapse of, 1114; resection of, 1137; stricture of, 1114, 1130; ulcer of, 1119, 1124; villous tumour of, 1138
Recurrent dislocations, 569
  fibroid, 132
  hæmorrhage, 210, 226
  pulsation, 259, 279
Redressement, 374
Red softening of brain, 742; of cord, 775, 810
Reduction of dislocations, 557
Reef-knot, 281
Referred pain in hip-disease, 661
Reflex paralysis, 322
  spasm after nerve-injury, 322
Reflexes in spinal injury, 776
Regeneration of nerves, 315
Reid's bandage for aneurysm, 261, 279
Relapsing typhlitis, 1075
Reminders in syphilis, 87
Remittent fever, 11
Renal calculus, 1152; colic, 1153; cysts, 1151; fistula, 1167; hæmaturia, 1177
Repair, action of leucocytes on, 5; of arteries, 212; complications of, 157; of dislocations, 554; effect of nutrition on, 3; of fractures, 380; epidermis, 153; of nerves, 316; tissue-changes in, 4; of wounds, 151
Resection, osteoplastic, of ankle, 686; in delayed union, 391; in fractured patella, 479; of intestine, 1087; rectum, 1137;

ribs, 999; subperiosteal, 507; superior maxilla, 869
Residual abscesses, 29, 404, 657
urine, 1240
Resilient stricture, 1273
Resolution of thrombi, 243
Resorcin in favus, 205
Respiration in fracture of spine, 779; in scoliosis, 806
Rest as a cause of anchylosis, 692; compared with arthrectomy, 657; in arthritis, 621; in caries, 795; after dislocations, 559; in inflammation, 13; in synovitis, 615
Restraint in delirium tremens, 146
Retained testis, 1302
Retention cysts, 113, 1360
Retention of urine, 1193; in fractures, 397; after piles, 1113; in stricture, 1281
Reticular lymphangeiectasis, 312
Reticulated urethra, 1275
Retina, detachment of, 838; in myopia, 817; hæmorrhage into, 839; rupture of, 821; glioma of, 131
Retinitis pigmentosa, 838
Retinochoroiditis, 821
Retromaxillary polypi, 869
Retropharyngeal abscess, 794
Rhabdosarcoma, 131
Rhagades, 84, 89
Rheumatic arthritis, 636; gout, 637; inflammation, 17; iritis, 830; nodes, 521; ostitis, 522; phlebitis, 247
Rheumatism, gonorrhœal, 631
Rheumatoid arthritis after dislocations, 559; compared with fracture of femur, 464
Rhinoscleroma, 858
Ribs, beading of, 528; fracture of, 983; resection, 999
Rickets, 526; acute, 532; as a cause of flat-foot, 366; knock-knee, 371; fracture, 378; and scurvy, 532; of skull, 527, 535, 738; of spine, 801; visceral changes, 529
Rider's-bone, 126, 331
Right-angled contraction, 365
Rigidity of jaws, 882; of muscles, 365
Rigor, 26, 158; in pyæmia, 59
Ringworm, 204
Risus sardonicus, 107
Rizzoli's operation on jaws, 883
Robson, Mayo, 321
Rodent ulcer, 137; on eyelid, 844; on face, 859
Rosenmüller, organ of, 116
Roseola, recurrent, 85; syphilitic, 84
Rotation in reduction of dislocated humerus, 573; in scoliosis, 803
Roth on curvature of spine, 807
Rouge's operation, 865
Roux's amputation, 1378
Reduction *en masse*, 1025
Ruffer, 111
Rules for ligature of arteries, 280
Rupia, 84, 101
Rupture of aneurysm, 255, 278; arteries in fractures, 399; bladder, 1186; ectopic gestation, 1324; globe, 821; hernial sac, 1025; muscles, 332; of abdomen, 1002; perineum, 1350; stricture, 1284; urethra, 1256; in lithotomy, 1223

S

Sac, anatomy of hernial, 1011; in radical cure, 1039; rupture of, 1025
Sacculated aneurysm, 249
Sacculus of bladder, 1199, 1208, 1275
Sacrococcygeal cysts, 117; tumours, 769
Sacroiliac disease, 676; and hip-disease, 668
Sacrum, fracture of, 454
Sailors, fractures in, 389
Sal-alembroth, 160
Salicylic creosote plaster in lupus, 193; ringworm, 206; warts, 202
Salivary calculi, 912; division of duct of, 854; fistula, 854; inflammation of gland, 911; tumours of, 912
Salivation in syphilis, 98
Salmon and Ody's truss, 1015
Saphena vein, varix of, 240
Sapræmia, 21, 157
Sarcoma and aneurysm, 255, 276; of bone, 541; of breast, 1362; cysts in, 115; of dura mater, 740, 757; degeneration of, 132; as a cause of fracture, 379; generalisation of, 133; of iris, 829; jaws, 887; kidney, 1151; ovary, 1326; malignancy of, 132; skull, 740, 757; testes, 1312; varieties of, 128
Sayre's bandage in fracture of clavicle, 427
jacket in caries of spine, 796; fracture, 784
Scabbing of wounds, 153
Scabies, 202
Scalds, 176; of the eye, 818; of glottis, 946
Scalp, cellulitis of, 53, 736; diseases of, 735; cysts of, 117, 737; tumours of, 737; wounds of, 707
Scapula, dislocation of, 565; fracture, 429; sarcoma, 545
Scarification of larynx, 947
Scarlatinal arthritis, 631; inflammation of neck, 948
Scarpa's shoe, 360
Scars, 172
Schede's dressing, 167
Schizomycetes, 1
Schrapnell's membrane, 916
Sciatic aneurysm, 276; dislocation of hip, 591; compared with fracture, 463; hernia, 1049; nerve, stretching of, 237
Scirrhus, 139, 1362; of intestine, 1064
Scissor-legged progression, 664
Sclerosis, 493, 516
Scoliosis, 801
Scott's dressing, 618
Scraping lupus, 192; lymph-glands, 308; tongue, 895, 901
Scrofula, 74

Scrofulous arthritis, 649 ; eczema, 186
Scrotum, diseases of, 1300 ; examination of, 1300
Scurvy, as a cause of fracture, 379 ; and rickets, 532
Sebaceous cysts, 114 ; of scalp, 737 ; of face, 859
Secondary amputation, 417, 1371
  hæmorrhage, 210, 259 ; in fractures, 401, 417 ; after piles, 1113 ; in cleft palate, 874 ; treatment of, 226
  nodes, 514
Section of the spinal cord, partial, 786
  perineal, 1289
Semilunar cartilages, dislocation of, 599 ;
Semimembranosus bursa, 348 ; cysts, 644
Senile cataract, 832 ; gangrene, 43 ; struma, 98 ; tuberculosis, 655
Senn, on enterorrhaphy, 1088 ; intestinal anastomosis, 1090 ; omental grafting, 1088 ; injection of hydrogen gas, 1004
Sensation in injury to spine, 777
Separation as a cause of non-union, 388
  of epiphyses, 396 ; of femur, 470, 472 ; of humerus, 432, 580 ; in ostitis, 506 ; of radius, 444 ; osseous union after, 470 ; of tibia, 488
Septic fever, 20, 157
  infection, 66
  inflammation in wounds, 157
  intoxication, 21
Septicæmia, 66
Sequestra after amputation, 512, 1384
Sequestrotomy, 510
Serocystic disease, 115, 1361
Serous cysts of breast, 1359
  exudation, 8
  iritis, 830
Serpiginous eruptions, 90
  ulcers, 198
Sessile hæmorrhoids, 1108
Shattock, 354
Sheath of arteries, method of opening, 281
Shock, 141 ; death from, 747 ; diagnosis from hæmorrhage, 143 ; in fractures, 396 ; as a cause of suppression, 1145 ; operations during, 143 ; from passage of catheter, 1261 ; in railway accidents, 787
Shortening in hip-disease, 665
Shoulder, amputation at, 1373 ; dislocation of, 566 ; unreduced, 554, 576 ; disease of, 686 ; excision of, 696 ; fracture into, 435 ; frequency of dislocation of, 552 ; growing out of, 803 ; osteoarthritis of, 641 ; paralysis of muscles of, 557 ; shape of, in synovitis, 614
Signoroni's tourniquet, 218
Silicate of soda splints, 409
Silk ligatures, 222
Simple caries, 495
Sinus, 36 ; thrombosis of lateral, 752
Size of urethra, 1277
Skin, diseases of, 183 ; grafting, 154 ; transplantation, 173
Skull : craniotabes, 527, 738 ; exfoliation from, 508 ; fracture of, 710 ; inflammation after, 744 ; hypertrophy of, 738 ; nodes on, 515 ; osteoma of, 740, 744 ; in osteomalacia, 535 ; ostitis of, 739 ; in ostitis deformans, 533 ; in rickets, 527, 535, 738 ; sarcoma of, 741 ; syphilitic inflammation, 91, 515, 739 ; tubercular diseases, 739 ; tumours of, 740
Sloughing in fracture, 402 ; in intussusception, 1054, 1063 ; in spinal injury, 777
Smith's gag, 872 ; tubular needles, 873 ; Nathan Smith's splint, 469, 482
Smoker's patch, 89, 895
Snuffles, 95, 864
Soap in eczema, 186
Soft chancre, 79
Softening of brain, 742 ; of spinal cord, 775, 810
  of thrombi, 244
Solid œdema, 16, 312
Solution of calculi, 1157
Sonnenburg, cystectomy, 1237
Sounding for calculi, 1209
Sounds, Bellocq's, 863 ; bulbous, 1279 ; for diagnosis, 1279
Spanton's operation for hernia, 1039
Spasm in arthritis, 615, 620 ; cortical, after head-injury, 723 ; of larynx, 935 ; in swallowing, 976 ; in tetanus, 107
Spasmodic closure of jaws, 882
  contraction after nerve-injury, 322
  croup and rickets, 530
  stricture, 1272, 1279
Spastic paralysis, 744 ; rigidity, 365
Speculum : anal, 1103 ; aural, 916
Spence's amputation, 1373
Spencer Watson's operation, 825
Spermatic cord, diagnosis of tumours of, 1301
Spermatocele, 115
Spheroidal-celled carcinoma, 139
Spina bifida, 765 ; false, 766
  ventosa, 524
Spinal canal, narrowing of, in caries, 791
  cord, compression of, in caries, 791 ; inflammation of, 809 ; injuries of, 785 ; tumours of, 812
  curvature, 800
Spine, caries of, 789 ; dislocation of, 773 ; fracture, 773 ; railway, 771, 787 ; in rickets, 528 ; sprains of, 770
Splicing nerves, 321 ; tendons, 323
Splint, Bavarian, 484 ; Bryant's, 470, 669 ; Carr's, 449 ; Croft's, 484 ; Desault's, 465 ; Dupuytren's, 487 ; Ellis's, 427 ; Erichsen's, 432 ; extemporised, 404 ; in fractures of the leg, 481 ; Gamgee's, 409, 485 ; Gordon's, 448 ; Hammond's, 421 ; Hodgen's, 469, 482 ; interdental, 420 ; leather for fracture of patella, 478 ; Lister's, for wrist, 701 ; Liston's, 465 ; MacIntyre's, 469 ; Middeldorpf's, 437 ; movable, 408, 482 ; Nathan Smith's, 469, 482 ; plaster, 409, 484 ; poroplastic, 408, 484 ; Pott's, 482 ; in rickets, 531 ; for semilunar cartilages,

602; in spinal caries, 796; in spinal fracture, 783; stocking, 483; in talipes, 356, 359; Thomas' hip, 672; knee, 467, 683; for jaw, 422
Splinters in fractures, 414
Spontaneous aneurysm, 249
    cure of aneurysm, 253
    fracture in sarcoma, 544
    regeneration of nerves, 315
Sprains, 550; of back, 770; of flexor tendons, 449
Spur formation in artificial anus, 1092; in colotomy, 1083
Staff in lithotomy, 1218, 1224; Syme's 1288; Wheelhouse's, 1290
Stages of hip-disease, 668
Staphylococci, 2, 23, 56, 158, 501
Staphyloma, posterior, 817
Starch in rickets, 529; for splints, 408
Starting pains, 621
Stasis, 4
Stephen Smith's amputation, 1377
Stercoral ulcers, 1064
Sterility and varicocele, 1315
Sternomastoid, division of, 950; induration, 950; rupture, 322
Sternum, injuries of, 985
Sthenic fever, 10
Stiffness after dislocations, 559
Stimson, 584
Stimulants in delirium tremens, 146; in gangrene, 47; gout, 636; hæmorrhage, 213; inflammation, 16, 55, 65; intestinal strangulation, 1058, 1061; shock, 144
Stirrup for fracture of femur, 466
Stocking splint, 483
Stokes, 368; amputation, 1377
Stomach, operations on, 1007
Stomatitis, 856, 875
Strabismus, 816, 840
Strangulation by bands, 1050; in hernia, 1019; internal, 1049; of peritoneum, 1024; of piles, 1108; symptoms of, in hernia, 1021
Strangury, 1200
Strapping, 164; of testis, 1306
Streptococcus, 2, 23, 52, 158, 501
    erysipelatis, 62
Stretching nerves, 325, 327
Stricture of intestine, 1064; after hernia, 1032; as a cause of strangulation, 1054
Stricture of œsophagus, 977
    of rectum, 1130; after piles, 1111
    of urethra, 1272; cure of, 1289; dilatation of, 1280; division of, 1284; effects of, 1274; electrolysis in, 1291; excision of, 1291; locality, 1273; measurement, 1279; retention in, 1195; rupture of, 1284; symptoms of, 1275; traumatic, 1256
Struggling in anæsthesia, 1385
Strumous arthritis, 649; lupus, 190; ostitis, 523
    and syphilitic nodes, 521
Stumps, diseases of, 1382; hæmorrhage from, 227; neuralgia of, 326
Styes, 843
Styptics, 224
Subarachnoid hæmorrhage, 720, 729
Subastragalar amputation, 1380; dislocation, 607
Subcæcal fossa, 1050
Subclavian aneurysm, 261, 272; artery, compression of, 288; ligature, 286
    and carotid arteries, ligature of, 261
Subclavicular dislocation, 568
Subcoracoid dislocation, 567
Subcranial hæmorrhage, 727; nodes, 516; suppuration, 746
Subcutaneous nerve-stretching, 327
    urethrotomy, 287
Subdural abscess, 753; suppuration, 746; hæmorrhage, 720, 728
Subglenoid dislocation, 567
Subhyoid cysts, 117; pharyngotomy, 959
Sublingual bursa, 885; cyst, 118
Subluxation, 552; of clavicle, 564; humerus, 568; lower jaw, 562; radius, 583
Submammary abscess, 1356
Submaxillary tumours, 913
Submucous fibroids, 1340
Subperiosteal cysts, 888; excision, 696; hæmorrhage in rickets, 532; resection, 507
Subperitoneal fatty hernia, 1047; fibroids, 1341; lipoma, 121
Subspinous dislocation, 568
Subungual exostosis, 538
Suction cannula for tracheotomy, 955
Sugar in urine, 1178
Suggestion, 788
Suicidal wounds of throat, 937
Sulphide of calcium, 196
Sulphurous acid in tinea, 207
Superficial glossitis, 895
Superior maxilla, fracture of, 418; resection, 869
Supernumerary fingers, 350
Supports in caries of spine, 796; in curvature, 809
Suppression of urine, 1145
Suppurating bubo, 83, 304
Suppuration in aneurysm, 254, 260; in antrum, 880; in burns, 177; in compound fractures, 385; catarrhal, of joints, 613; diffuse, 24, 29; and embolism, 28; after extravasation of blood, 149; and hæmorrhage, 226; intracranial, 746; of scalp, 736; in spinal caries, 792, 799; symptoms, 24; in syphilis, 87; in wounds, 152, 158
Suppurative arthritis, 548, 625; arteritis, 234; bursitis, 348; fever, 27; meningitis, 747; microbes, 23; orchitis, 1310; ostitis, 501; of skull, 739, 512; otitis, 754; parotitis, 912; peritonitis, 1077; phlebitis, 246; pyelitis, 1156, 1162; prostatitis, 1252; tenosynovitis, 340
Supracoracoid dislocation, 568

SUP

Suprapubic cystotomy, 1235 ; lithotomy, 1226 ; prostatectomy, 1249
Supraspinous dislocation, 596
Supravaginal hysterectomy, 1343 ; amputation of cervix, 1346
Surgical emphysema, 991 ; kidney, 1146, 1164
Sutures, 164 ; of bladder, 1188 ; after cystotomy, 1227, 1236 ; Czerny's, 1087 ; Greig Smith's, 1087 ; in fracture of patella, 477 ; Joubert's, 1088 ; Lembert's, 1086 ; of nerves, 319 ; in scalp wounds, 709 ; of tendons, 333 ; of urethra, 1257 ; in wounds of neck, 939
Sweep's cancer, 1300
Sycosis, 185, 841
Syme's amputation, 1378 ; gluteal aneurysm, 277 ; staff, 1288 ; tenotomy, of posterior tibial, 358 ; urethrotomy, 1288
Symmetrical gangrene, 64
Symmetry in syphilis, 85
Sympathetic irritation, 820 ; ophthalmia, 820 ; paralysis, 778
Syncope in anæsthesia, 1385 ; from catheters, 1262
Synovial fringes, hypertrophy of, 509, 639, 689
  herniæ, 617, 640
  pouches, 617
  sheaths of tendons, arrangement of, in palm, 342 ; inflammation of, 338
Synovitis, 608, 613 ; after injury, 547 ; hæmorrhagic, 233 ; in osteoarthritis, 639 ; papillary, 639 ; in syphilis, 682 ; tubercular, 650
Syphilis, 78 ; acquired, 81 ; as a cause of fracture, 379 ; choroiditis in, 828 ; duration of contagiousness, 87 ; of hereditary transmission, 87, 94 ; eruptions, 85 ; on the face, 857 ; hereditary, 95 ; intermediate, 89 ; iritis, 828 ; lupus, 192 ; marriage in, 94, 102 ; and phagedæna, 50 ; prognosis of, 93 ; second attacks of, 93 ; secondary, 83 ; teeth in hereditary, 96, 828 ; tertiary, 87
Syphilitic arteritis, 235 ; as a cause of aneurysm, 250 ; caries, 497 ; epididymitis, 1305 ; glossitis, 897 ; laryngitis, 931 ; neuritis, 324 ; orchitis, 1307 ; ostitis, 514, 518, 739 ; phlebitis, 248 ; pemphigus, 190 ; stomatitis, 877 ; synovitis, 682 ; ulcers, 197 ; of rectum, 1120 ; urethritis, 1268
Syringocele, 766

T

Tagliacotian operation, 862
Tait, on operations on the gall-bladder, 1098
Talipes, 353 ; acquired, 361 ; arcuatus, 363 ; calcaneus, 353, 363 ; equinovarus, 353 ; equinus, 362 ; plantaris, 363 ; relapsed, 360 ; valgus, 354, 363

THR

Tampon for rectum, 1113 ; Buckston Browne's, 1222 ; laryngeal, 957
Tapping the bladder, 1196 ; hydrocele, 1319 ; ovarian cysts, 1334
Tar as a cause of acne, 194 ; in eczema, 186 ; lichen, 189 ; lupus, 194 ; psoriasis, 188
Tarsectomy, 360
Taxis, 1024 ; accidents from, 1025 ; duration of, 1027 ; for inguinal hernia, 1036
Teale's amputation, 1372, 1378
Teeth in hereditary syphilis, 96, 828 ; in rickets, 527
Temperature in cortical lesions, 725 ; in fracture of spine, 779 ; after nerve-section, 317
Temporal artery, ligature of, 286
Temporo-maxillary articulation, anchylosis of, 883
Tendo Achillis, contraction of, 365 ; rupture of, 333 ; section of, 358, 471, 482, 487
Tendons, dislocation of, 334 ; section of, 357 ; splicing, 333 ; suture, 333 ; union, 357
Tenosynovitis, 358
Tenotomy, 171, 357 ; of palmar fascia, 345 ; in fractures, 406, 471, 487 ; of sternomastoid, 950 ; for strabismus, 846
Tension of eyeball, 833 ; as a cause of inflammation, 16, 149, 169
Teratomata, 118
Tertiary nodes, 515
Testis, dermoid cysts of, 118 ; enchondroma of, 125 ; hernia, 1310 ; inflammation, 1304 ; malformations of, 1302 ; puncture of, 1306 ; sarcoma of, 131 ; strapping, 1306 ; tumours of, 1311 ; undescended, with hernia, 1037
Tetanus, 105, 323 ; after fractures, 398 ; hydrophobicus, 105
Thecal abscess, 340
Thiersch, amputation of penis, 1299 ; dressing for wounds, 161 ; extroversion of bladder, 1185 ; method of grafting, 156
Third nerve, injury to, 730
Thomas' boot for flat-foot, 367 ; diagnosis of hip-disease, 663 ; splint for hip, 672 ; jaw, 422 ; knee, 467, 683 ; double, for spine, 798 ; wrench, 673
Thompson's bladder-forceps, 1235
Thoracic duct, wounds of, 302
Thoracoplasty, 999
Thorax. *See* Chest
  deformity in caries, 791 ; in curvature of spine, 805
Thorburn, injuries of spine, 776, 788
Thrill in aneurysm, 252
Throat, scald of, 946 ; wound of, 937
Thrombosis, 4 ; of arteries, 237 ; in fractures, 401 ; of lateral sinus, 271, 752 ; in pyæmia, 57 ; traumatic, 229 ; of veins, 241

Thrombotic abscesses, 58 ; gangrene, 43 piles, 1106
Thrush, 876
Thumb, amputation of, 1374 ; avulsion of, 332 ; dislocation of, 585
Thyroarytenoid muscles, paralysis of, 935
Thyroid gland, cysts of, 953, 967 ; accessory ones, 969 ; enlargement of, 966 ; fibrous degeneration, 968 ; inflammation, 965 ; malignant disease of, 972 ; operations on, 971
Thyroid dislocation of hip, 594
Thyro-lingual canal, 952
Thyrotomy, 959 ; for carcinoma, 932
Tibia, fracture of, 485 ; with fibula, 480 ; in rickets, 529 ; separation of epiphysis of, 488 ; syphilitic disease of, 520 ; tubercular, 651
Tibial arteries, ligature of, 298 ; wound of, 221, 400, 488
  tendons, dislocation of, 334 ; division, 357
Tic, 326
Tilleman, 321
Tilting of pelvis, 664
Tinea, 205 ; of face, 854 ; versicolor, 207
Tinnitus aurium, 923
Tobacco amaurosis, 837
Toes, amputations of, 1381 ; deformities of, 368
Tongue, hypertrophy of, 892 ; inflammation, 893 ; leucoplakia, 896 ; malformations, 892 ; operations on, 902 ; syphilis of, 897 ; tubercle of, 899 ; tumours of, 899 ; ulceration, 895
Tonsillotome, 910
Tonsils, calculi in, 911 ; excision of, 910 ; hypertrophy of, 908 ; inflammation, 907 ; suppuration, 908 ; tumours, 911 ; wounds, 225, 285
Tophi, 634
Torsion of arteries, 222 ; of hernial sac, 1040
Torticollis, 949
Tourniquets, 217 ; Jordan Lloyd's, 1375 ; for reduction of dislocated jaw, 562
Trachea dilator, 945, 955
  exploration of, 945 ; foreign bodies in, 943 ; ulceration after tracheotomy, 959 ; wounds of, 938
Tracheotomy, 953 ; for foreign bodies, 945 ; in goitre, 971 ; for scald, 947 ; tubes, 955
Trachoma, 823
Transfusion in hæmorrhage, 213 ; in shock, 144
Transmissibility of syphilis, 87
Transplantation of bone, 397 ; frog's skin, 156 ; muscle, 333 ; mucous membrane, 156 ; nerves, 321 ; skin, 156, 173
Traumatic aneurysm, 214 ; in fractures, 400 ; treatment of, 227, 264
Traumatic cataract, 819 ; mydriasis, 820
  delirium, 146

Traumatic epilepsy, 734
  fever, 20, 146, 170
  gangrene, 46
  insanity, 735
  nodes, 498
  stricture of œsophagus, 979 ; urethra, 1256
  synovitis, 547
  ulcers, 200
Traumatopnœa, 986
Tremor in delirium, 144
Trendelenburg's operation for ectopia, 1185 ; tampon, 957
Trephining, 761 ; for cerebral abscess, 755 ; hæmorrhage, 733 ; tumour, 760 ; the chest, 998 ; in chronic meningitis, 754 ; for epilepsy, 734 ; for fracture of skull, 714 ; for insanity, 735 ; in ostitis, 500, 507, 624, 685 ; for rupture of middle meningeal, 732 ; mastoid cells, 921
Trephining the spine, 812 ; for disease, 800 ; for injury, 785
Treves on intussusception, 1061 ; obstruction, 1066 ; splint, 308 ; on strangulation, 1059 ; typhlitis, 1075
Trichiasis, 825
Tricophyton, 204
Tripier's amputation, 1380
Tripolith, 409
Trismus, 105 ; neonatorum, 106
Trophic lesions after nerve-section, 317 ; in spinal injury, 777, 810
Trusses, 1013
Tubage for dyspnœa after tracheotomy, 958 ; of larynx, 960 ; œsophagus, 980
Tubercle, anatomical, 74 ; bacillus of, 73 ; infection by, 75 ; in lupus, 190 ; painful subcutaneous, 120
Tubercular abscesses, treatment of, 657 ; adenitis, 306 ; of neck, 949 ; arthritis, 649, 659 ; bursitis, 347 ; caries, 496, 525 ; of skull, 739 ; of spine, 789 : disease of brain, 758 ; of bone, 624, 659, 679 ; of choroid, 840 ; of chest wall, 995 ; of iris, 829 ; of larynx, 929 ; of tendons, 339 ; of tongue, 899 ; peritonitis, 1079 ; prostatitis, 1253 ; pyelitis, 1162 ; sequestra, 659 ; stomatitis, 878 ; ulceration of skin, 198 ; of intestine, causing stricture, 1064 ; of rectum, 1120 ; urethritis, 1268
Tubercular leprosy, 103
Tuberculosis, senile, 656
Tubes, tracheotomy, 955
Tubular lymphangeiectasis, 312
Tufnell's treatment of aneurysm, 256
Tumor albus, 678
Tumours, 113 ; of bladder, 1230 ; brain, 758 ; bone, 537 ; choroid, 840 ; jaws, 881 ; kidney, 1151 ; larynx, 931 ; mouth, 884 ; meninges, 757 ; nares, 867 ; orbit, 841 ; salivary glands, 912 ; scalp, 737 ; skull, 757 ; spinal cord, 812 ; scrotum, 1300 ; testis, 1311 ; tongue, 899 ; tonsils, 911

Tying-in catheter, 1263
Tympanitic abscesses, 29
Typhlitis, 1074
Typhoid, arthritis after, 631; necrosis, 514
Twisted suture, 165
Twisting of ovarian pedicle, 1333

U

Ulcer, atheromatous, 237; of bladder, 1200; cancerous, 139; of duodenum, 178; face, 859, 861; intestine, 1064; leg, 198, 241; perforating of foot, 317, 647; of rectum, 1119, 1124; rodent, 137; on eye, 844; on face, 859; of scars, 174; syphilitic, 90; of tongue, 895; varieties, 38, 196
Ulceration, 37
Ulcerative endocarditis, 235, 246
    stomatitis, 876
Ulna, dislocation of, 582; fracture, 449
Ulnar artery, ligature of, 293
Umbilical hernia, 1046
Union of epiphyses, 433, 470, 488, 495; premature in rickets, 527; in syphilis, 519
    by first intention, 151; by granulations, 152; under a scab, 153
    of fractures, 380; delayed, 386; failure of, 387; fibrous, 386; of neck of femur, 458; of patella, 475; of skull, 716
    of nerves, 315
Unna, 186, 193
Unreduced dislocations, 554; of elbow, 582; femur, 596; radius, 583; shoulder, 576
Ununited fracture, 386; of patella, 478
Urachus, cysts in, 116
Uræmia and concussion, 726
Urate of soda in gout, 634
Urea, amount of, 1174
Ureter, catheterisation of, 1168; obstruction, 1146, 1157
Ureterotomy, 1157
Urethra, calculus in, 1258; dilatation of, in stricture, 1275; of female, 1236; diseases of female, 1296; effect of catheters on, 1259; foreign bodies in, 1259; inflammation of, 1264; irritable, 1280; rupture of, 1256; in lithotomy, 1223; stricture of, 1272; suture of, 1257; tying catheter in, 1264; traumatic stricture of, 1256; washing out, 1269
Urethral arthritis, 631; caruncle, 1297; epididymitis, 1304; fistula, 1295; fever, 1262; hæmaturia, 1178; prostatotomy, 1248
Urethrameter, 1277
Urethritis, retention in, 1183
Urethrocele, 1297
Urethroscope, 1271
Urethrotomy, 1284
Uric acid, amount of, 1174
Urinary abscess, 1293
    fistula, 1167, 1295
Urine, deposits in, 1179; extravasation of, 1291; from kidney, 1143; incontinence of, 1192; organisms in, 1181; reaction of, 1174; retention of, 1193; after piles, 1113; secretion of, in fractured spine, 780; specific gravity, 1173; suppression of, 1145; surgical aspect of, 1172; variations in quantity, 1173
Uterine appendages, removal of, 1323, 1342
    and ovarian tumours, diagnosis of, 1332
Uterus, cancer of, 1345; cervix, amputation of, 1346; laceration of, 1349; extirpation of, 1347; tumours of, 1338

V

Vagina, affections of, 1348
Vaginal hydrocele, 1316
Valsalva, method of inflating ear, 915
Varicocele, 1314; diagnosis of, 1301; operation for, 1316; and wasting of testis, 1315
Varicose ulcer, 241; vein, 239
Varioloid eruption in syphilis, 84
Varix, aneurysmal, 228; arterial, 232; of internal saphena, 240; of lymphatics 313
Varus, spurious, 356, 365
Vascular growth of urethra, 1297, 1348
Vault of skull, fracture of, 711
Veins: entry of air into, 230; injury of, 229; ligature of artery and, 229; ligature in pyæmia, 753; ruptured, in fractures, 400; varicose, 239
Velpeau, dislocation of clavicle, 564, 566
Venous hæmorrhage, 209; hæmorrhoids, 1107; nævi, 137, 231; pulsation in glaucoma, 834; obstruction, 244
Ventral hernia, 1047
Verneuil, 1104
Verrucæ, 86, 133; necrogenic, 191
Vertebræ, rotation of, in curvature, 803
Vertebral artery, ligature of, 288; wound, 225, 939
    column. *See* Spine
Vertigo, auditory, 924
Vesical calculus, 1203; hæmaturia, 1178
Vesicle, 183
Vesicovaginal fistula, 1349
Vesicular eruptions after nerve-section, 317
Vessels, formation of, 6; injuries, 209; occlusion, 215
    of neck, wounds of, 939
Villous cancer, 115; growths, 133; tumour of bladder, 1230; of rectum, 1138
Vinolia, 186
Virus of hydrophobia, 111
Viscera, abdominal, rupture of, 1002; wounds, 1005

Visceral changes in rickets, 529
    congestion in burns, 178
Vision, limitation of field of, 837
Vitreous, escape of, 840; hæmorrhage into, 839
Volkmann's spoons, 192
Volvulus, 1052, 1056; after hernia, 1032; treatment of, 1061
Vomiting in anæsthesia, 1385; in hernia, 1022, 1055; after herniotomy, 1032; in obstruction, 1068
Vulcanite splints in fracture of jaw, 421
Vulva, affections of, 1348

W

Walsham's shoe, 367
Wardrop's method of ligature, 259, 260
Warmth in arthritis, 616; in inflammation, 14
Warts, 201
Washing-out bladder, 1202; in enlarged prostate, 1246
    urethra, 1269
Wasting after ligature of arteries, 225; after inflammation of joints, 615, 640, 665
Wax in ear, 917
Weakness as a cause of spinal curvature, 803
Webbed fingers, 353
Webbing straps for fracture of jaw, 420
Wedges in reduction of dislocated jaw, 562
Wharton's duct, cyst from, 115
Wheal, 183
Wheelhouse's perineal section, 1289
Whip bougies, 1282
Whitehead: on excision of tongue, 903; on piles, 1112; prolapse, 1116; tracheotomy, 954
Whitehead's varnish, 906
Whitlow, 340; after nerve-section, 317
Wilson's cystometer, 763
Wire, introduction of, in aneurysm, 263
    splint for fracture of jaw, 421
Wiring in fracture of jaw, 421; in delayed union, 391
Wolffian cysts, 116
Wolfler's method of grafting, 156
Wood's operation for ectopia vesicæ, 1184; for radical cure of hernia, 1039; pads, 1014
Wood-wool, 163
Wool-sorter's disease, 67
Wool truss for inguinal hernia, 1016
Wounds of abdomen, 1004; air-passages, 938; arteries, 211, 216; brain, 727; chest, 985; cord, 786; cellulitis after poisoned, 52; decomposition in, 157; drainage of, 162, 167; dressings for, 163; of the eye, 819; face, 853; in connection with fractures, 411, 414; of heart, 987; infected, 160, 168; inflammation in, 152, 157; inoculated by tubercle, 75; of joints, 546; lung, 986; neck, 937, 939; palate, 875; protection of, 169; repair of, 151; treatment of, 159; varieties of, 150, 170; of veins, 229; of viscera, 1005
Wrenches, Thomas', 673
Wrist, dislocation of, 584; excision of, 699; fracture into, 452; tubercular disease of, 688
Writer's cramp, 335
Wry-neck, 949; and spinal caries, 793
    as a cause of scoliosis, 803

X

Xanthelasma palpebrarum, 845

Z

Zygoma, fracture of, 419

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